2004 - C205

A. PROPOSAL SOLICITATION PACKAGE COVER SHEET

Proposal Title: San Joaquin River NWR Riparian Habitat Protection and Floodplain Restoration Project - Phase II
Applicant Name: U.S. Fish and Wildlife Service, San Luis National Wildlife Refuge Complex
Contact Name: Kim Forrest
Mailing Address: P.O. Box 2176, Los Banos, CA 93635
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Amount of funding requested: $ 7,646,233
Some entities charge different costs dependent on the source of funds. If it is different for state or federal funds list below.
State cost _____ Federal Cost _____

Cost share partners? ✓ **Yes** _____ **No**
Identify partners and amount contributed by each: U.S. Army Corp of Engineers - $1.4 million, U.S. Bureau of Reclamation - 360,000, U.S. Fish and Wildlife Service, $125,000.

Indicated the Topic for which you are applying (check only one box).

☐	Natural Flow Regimes	☐	Beyond the Riparian Corridor
☐	Nonnative Invasive Species	☐	Local Watershed Stewardship
☒	Channel Dynamics/Sediment Transport	☐	Environmental Education
☐	Flood Management	☐	Special Status Species Surveys & Studies
☐	Shallow Water Tidal/Marsh Habitat	☐	Fishery Monitoring, Assessment, & Research
☐	Contaminants	☐	Fish Screens

In what county or counties is the project located? Stanislaus County

In what CALFED ecozone is the project located? See attached list and indicate number. Be as specific as possible 12.1

Indicate the type of applicant (check only one box):

☐	State Agency	☒	Federal Agency
☐	Public/Non-profit joint venture	☐	Non-profit
☐	Local government/district	☐	Tribes
☐	University	☐	Private party
☐	Other: _____		

Indicate the primary species which the proposal addresses (check all that apply):

☒	San Joaquin & East-side Delta tributaries fall-run chinook salmon		
☐	Winter-run chinook salmon	☐	Spring-run chinook salmon
☐	Late fall-run chinook salmon	☐	Fall-run chinook salmon
☒	Delta smelt	☐	Longfin smelt
☒	Splittail	☒	Steelhead trout
☒	Green sturgeon	☒	Striped bass
☒	White sturgeon	☐	All chinook species
☒	Waterfowl and shorebirds	☐	All anadromous salmonids
☒	Migratory birds	☐	American shad
☒	Other listed T/E species: Riparian Brush Rabbit, Riparian Woodrat, Aleutian Canada Goose		

Indicate the type of project (check only one box):

☐	Research	☐	Watershed Planning
☐	Pilot/Decmo Project	☐	Education
☒	Full-scale Implementation		

Is this a next-phase of an ongoing project? Yes __X__ No _____
Have you received funding from CALFED before? Yes __X__ No _____

If yes, list project title and CALFED number _Acquisition and Restoration of Refuge Lands, 97-B04 (San Joaquin River NWR), Bear Creeek Floodplain Restoration Demonstration Project, 97-B05, (San Luis NWR), Lower San Joaquin River Floodplain Protection and Restoration Project, 98-F21, (San Joaquin River NWR).

Have you received funding from CVPIA before? Yes _____ No __X__

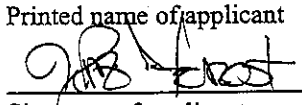
If yes, list CVPIA program providing funding, project title and CVPIA number (if applicable):

_____

By signing below, the applicant declares the following:

- The truthfulness of all representations in their proposal;
- The individual signing the form is entitled to submit the application on behalf of the applicant (if the applicant is an entity or organization); and,
- The person submitting the application has read and understood the conflict of interest and confidentiality discussion in the PSP (Section 2.4) and waives any and all rights to privacy and confidentiality of the proposal on behalf of the applicant, to the extent as provided in the Section.

Kim Forrest
Printed name of applicant



Signature of applicant

B. EXECUTIVE SUMMARY

Project Title: SAN JOAQUIN RIVER NATIONAL WILDLIFE REFUGE RIPARIAN HABITAT PROTECTION AND FLOODPLAIN RESTORATION PROJECT - PHASE II

Amount Requested: $7,646,233

Applicant Name: U.S. Fish and Wildlife Service, San Joaquin River National Wildlife Refuge

Address: San Luis National Wildlife Refuge Complex
P. O. Box 2176
Los Banos, California 93635

Phone: 209-826-3508
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Project Description: The U.S. Fish and Wildlife Service (USFWS) is proposing to initiate phase II of a project that will provide long term preservation and protection, and the restoration of over 11,000 acres of fish and wildlife habitat on and adjacent to the San Joaquin River National Wildlife Refuge (NWR) of the San Luis NWR Complex. Phase I of this project was funded by CALFED in 1997 and focused on fee and easement acquisitions, site clean up, biological inventory, and restoration planning. This proposal, Phase II, would fund the easement acquisition of approximately 400 acres of habitat adjacent to the refuge; restoration of 1,142 acres of riparian and wetlands habitat on refuge lands; a pilot re-introduction of riparian brush rabbits (Fed.- endangered species) onto refuge lands; and biological monitoring and evaluation. Project partners with the USFWS include the Army Corps of Engineers, Natural Resources Conservation Services, Bureau of Reclamation, California Department of Water Resources, Point Reyes Bird Observatory, and Sacramento River Partners.

Approach/Tasks: The proposed project encompasses several components in four district phases. This proposal seeks CALFED funding only for Phase II which includes:

Task A: Acquisition of a conservation easement from one willing seller east of the San Joaquin River.

Task B: Acquisition of flood easements at upper edge of floodplain to allow habitat restoration on Refuge owned land in the floodplain.

Task C: Breaching of flood control levees to allow flood flows into the floodplain restoration area.

Task D: Restoration of riparian and wetlands habitat on 1,130 acres through planting and growing native trees and shrubs, re-contouring leveled agriculture fields, installing water control structures, constructing refuge islands, and controlling invasive and noxious weeds.

Task E: Re-introduction of riparian brush rabbit (Federal endangered species) onto project site.

Task F: Monitoring and evaluation of restoration success.

Expected Products/Benefits: If fully funded, the total project will preserve 17.7 miles of existing riparian corridor along the San Joaquin River and adjacent oxbows, and restore about 3,600 acres of riparian forest and seasonal wetlands. The fee title and easement acquisitions will allow widening of the flood plain, provide transient storage of flood waters, facilitate ground water recharge, and allow riparian and wetland habitat restoration thus accomplishing a measure of downstream non-structural flood protection, as well as water quality, wildlife and fisheries benefits. Specific products and benefits from phase II will include acquisition of easement lands that will be managed to benefit Aleutian Canada geese (Fed.-threatened), greater sandhill cranes (State-threatened), and other migratory birds; provision of nonstructural flood control through easements; removal of flood control levees to allow restoration of floodplain functions; restoration of 812 acres of riparian habitat; restoration of 330 acres of wetlands; pilot re-introduction effort to establish a population of riparian brush rabbits back into suitable habitat; and an evaluation of restoration techniques and efforts on the biotic community to help guide future restoration efforts here and elsewhere. This proposal meets all six of the CALFED ERP goals listed in the 2001 proposal solicitation package.

C. PROJECT DESCRIPTION

1. Statement of the Problem

a. Problem Historically, the floodplain of the San Joaquin River was dominated by riparian forest. The plant community was comprised of tree species such as willows, Fremont's cottonwood, valley oak, and box elder, and shrub/forbs such as buttonwillow, California grape, rose, and blackberry. This riparian forest served many important ecological functions such as providing high quality wildlife habitat for resident and migratory species (TNC 1998); supplying shaded riverine aquatic habitat as a source of shelter and forage for fish species; improving water quality by acting as a sediment filter for upslope areas; and reducing downstream flooding by providing transient storage for floodwaters.

This floodplain as undergone extensive clearing for conversion to agricultural use. Wetland and riparian habitats have been reduced to less that five percent of historic levels. Lands within the project area currently support narrow riparian corridors, typically ranging from 10 to 50 meters wide. Consequently, fish and wildlife species which utilize these habitats have declined dramatically (USFWS 1998). In recognition of these losses, restoration of riparian and seasonal wetlands in the San Joaquin valley is considered to be a high priority of all State and Federal resources agencies

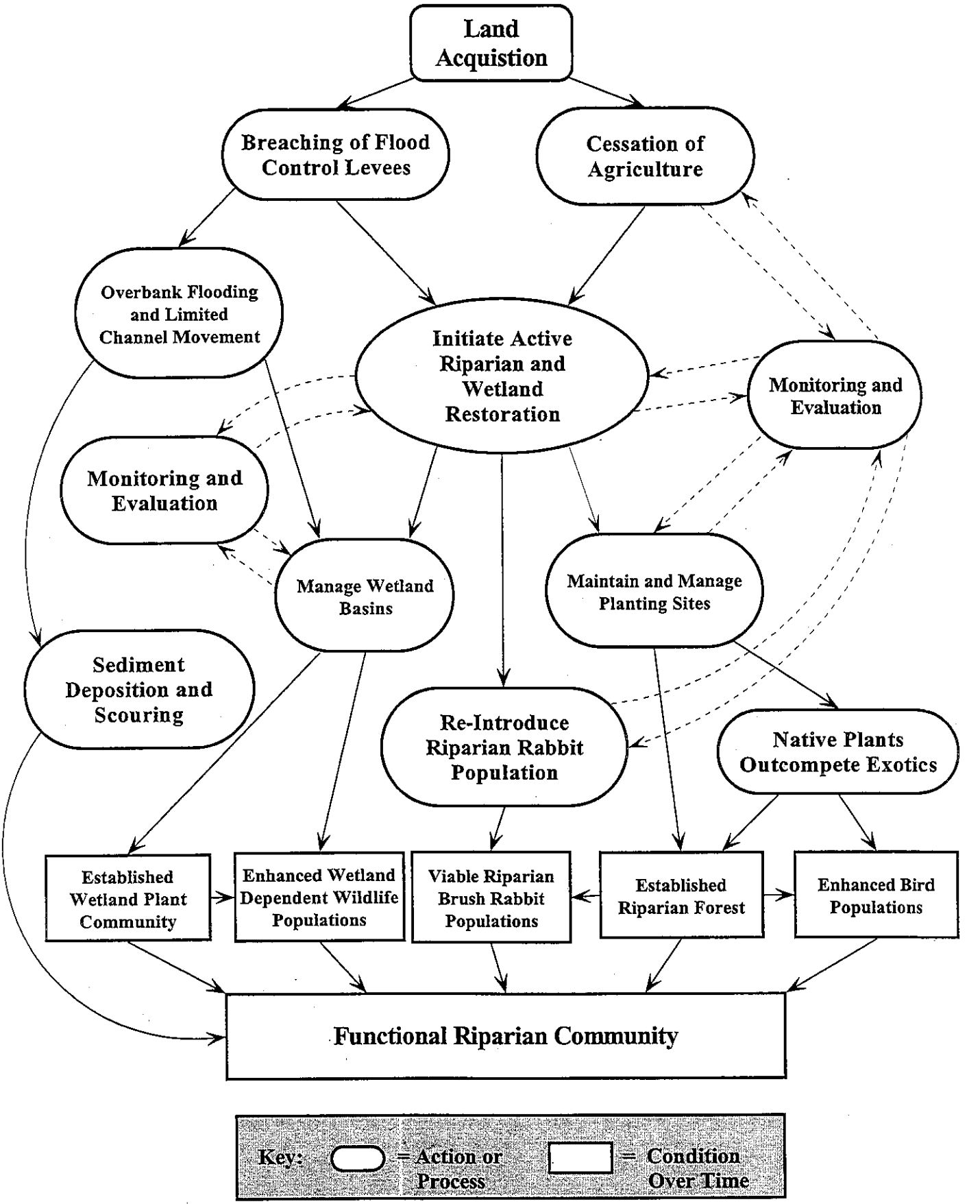
During January 1997, devastating foods swept through California's Central Valley, causing loss of an estimated $2 Billion in property damage. Stanislaus County was one of the most heavily impacted areas. The San Joaquin River escaped its banks, breached levees, inundated urban areas, and caused extensive farmland damage. Through Executive Order 11988, the Council for Environmental Quality and the Office of Management and Budget have directed the Army Corps of Engineers and other Federal agencies to explore cost-effective, non-structural flood protection projects.

Because of these issues, a multi-agency effort including the U.S. Fish and Wildlife Service (USFWS), Natural Resource Conservation Service (NRCS), Corps of Engineers (COE), Bureau of Reclamation (BOR), California Department of Water Resources, and others has been developed to address both flood control and riparian restoration issues along the San Joaquin River in Stanislaus County. Under this coordinated effort, land is being acquired by the USFWS and flood control easements are being purchased by the COE, which will eliminate the need to protect those floodplain lands from flooding. This in turn will allow a COE project levee and private levees to be breached or removed where appropriate to re-establish of flood-flow functions across the floodplain. Lands acquired in fee title by the USFWS will become part to the existing San Joaquin River National Wildlife Refuge (NWR) a unit of the San Luis NWR Complex. Under USFWS management, riparian and wetlands habitat will be restored .

b. Conceptual Model

Figure 1 is a pictorial representation of the actions and processes that would occur during active restoration of the San Joaquin River floodplain within the project. It is essentially a linear model in which acquisition of land allows the cessation of farming and the breaching of flood control levees. This in turn provides the conditions in which active tree/shrub planting, wetland restoration, and riparian brush rabbit (federal endangered species) can be re-introduced. The riparian planting sites will be intensively managed during establishment by using agricultural cultivation techniques, and newly created wetland basins maintained by conventional wetlands management techniques. Monitoring and evaluation will provide a flow of knowledge and information (depicted as dashed lines) that can be used to document the success or to alter both initial restoration and management actions of necessary to produce the desired outcome. Over time these actions and processes will produce the biological components of the riparian systems. These include wetland plant communities, riparian and wetlands dependant wildlife populations, enhanced neotropical migratory landbird populations and riparian forest communities. Hydrological processes, depicted as overbank flooding and channel movement with resultant deposition and scouring, would be introduced into the floodplain systems through breaching of the flood control levees. The impacts of these hydrological processes would vary over time depending on the magnitude of individual high-water or flood events. Over time, the hydrological processes will interact with the biological components to define the character of the resultant functionary riparian floodplain

Figure 1. Concept Model of Floodplain Restoration Project at San Joaquin River National Wildlife Refuge



c. Hypothesis Being Tested

This project revolves around the primary hypothesis that returning flood flows back to, and restoring 3200 acres of flood prone agricultural lands back to riparian and wetlands habitat will increase species richness and diversity of plants and wildlife and re-establish a functional riparian community within that floodplain.

d. Adaptive Management

This project seeks to restore hydrologic and biological functions to 3,300 acres of San Joaquin River floodplain by breaching levees, revegetating 3,166 acres of former agricultural fields back to riparian forest, and restoring former wetland basins. This will require a multi-year, multi-phase effort to accomplish this objective. That, plus the large project area will allow on-going data collection that can be used to evaluate success throughout the process and allow modifications in protocol and techniques to incorporate improvements to the project in an adoptive management framework. The methods for doing this on specific tasks include the following:

Riparian Planting Design - The plantings are designed as communities and are specifically tailored for each site based on soil type, hydrology, and probable past vegetation. Plant survival will be monitored on a regular basis so that patterns of species survival based on soil type and other factors can be identified quickly. This information can be used to make any necessary adjustments to future plantings.

Riparian Planting Field Reports - Sacramento River Partners contractors will maintain weekly records on activities at the planting sites. These include planting dates, timing of irrigation, herbicide applications, tillage, and other management actions. These records plus the monitoring information above will be used to direct future restoration efforts at individual sites and the rest of the project area.

Wetland Management Records - As wetland basins are developed and flooded, USFWS refuge staff will record water level information via staff gauge readings, assess effectiveness of water delivery and drainage systems, and evaluate plant and wildlife response to water management. This information will be used to assist in design and management of future wetland basins and to make any necessary modifications to management of that site.

Riparian Brush Rabbit Evaluation - Research personnel from the ESRP will closely monitor the re-introduction of riparian brush rabbits onto the refuge release site. Detailed records will be kept on dispersal patterns, habitat use, survival rates, recruitment and other parameters to guide the ongoing re-establishment effort at that site as well as future releases.

e. Educational Objectives

Information gathered during implementation of this project will be used to increase the knowledge base of restoration ecology. If appropriate, information on active riparian restoration and floodplain restoration will be presented in symposia or published form. Information gathered on flood flow patterns after beaching of the levees will be used to educate policy-makers on non-structural alternatives for flood management. Information gathered on the riparian brush rabbit re-introduction effort will be used to increase the knowledge base on the life history and biological requirements of the species and will be presented in symposia and published form.

2. Proposed Scope of Work

a. Location and/or Geographic Boundaries of the Project The proposed project is entirely within Stanislaus County along the floodplain of the San Joaquin River. This lies in Ecozone 12.1 (San Joaquin River - Vernalis to Merced). All of the acquisitions are within or adjacent to the boundaries of the San Joaquin NWR (Figure 2).

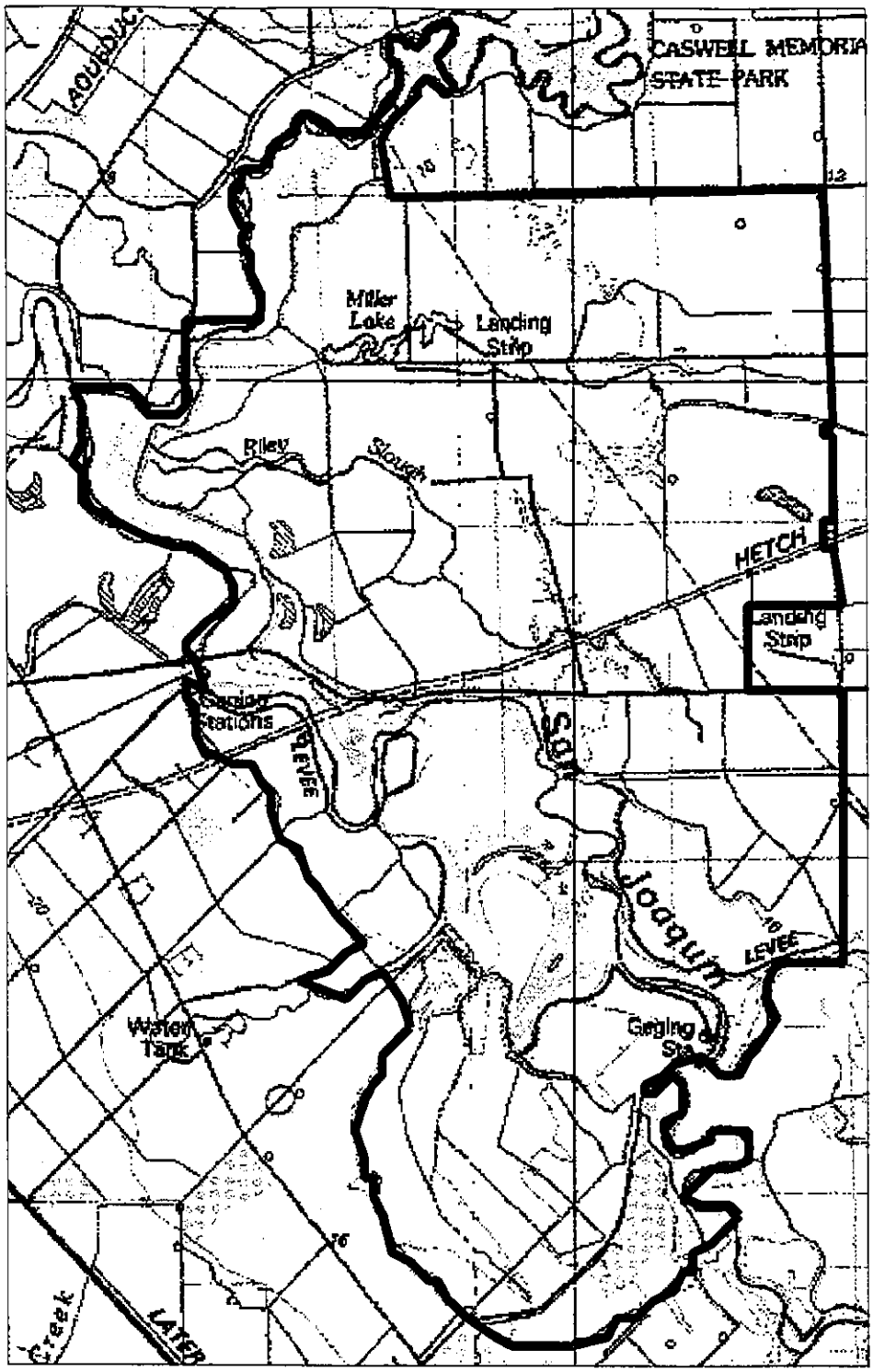


Figure 2. Project Area of the San Joaquin River National Wildlife Refuge Riparian Habitat Protection and Floodplain Restoration Project-Phase II.

* The Project Area center is within Zone 10 of the UTM coordinate system, 4168000m North, 65900m East.

b. Approach The proposed project encompasses several components in four distinct phases. This proposal seeks CALFED funding only for Phase II which includes: Task A, B, C, D, E, F.

Task A. *Acquisition of Conservation Easement* - The USFWS Sacramento Realty Office will acquire a perpetual conservation easement on lands (approximately 400 ac.)of the Mapes Ranch adjacent to easements acquired as part of Phase 1. Funds provided by CALFED will be used to leverage additional funds from other sources (Migratory Bird Conservation Act Fund, David and Lucille Packard Foundation) to purchase additional easements and complete an ongoing acquisition process that was begun with the establishment of the San Joaquin River NWR in 1987. A specific acquisition process will be followed, which includes:

Initial contact with willing seller (Permission to Appraise)	Completed
Preparation of Preliminary Project Proposal	Completed
Appraisal to approved federal standards	In Progress
Option for purchase agreement	
Title search	
Survey of property	
Level 1 contaminant survey	
Escrow and closing	
Recording of deed and purchase of property	

Task B. *Acquisition of Flood Easements* - This task will be accomplished by the COE using existing agency funds. Flood easements will be acquired on properties at the upper end of the project area floodplain using a process similar to that detailed in Task A. An earthen ring levee will be constructed around an irrigation district pump station at the edge of the floodplain to protect it from flooding. The intent of this work is to protect property and facilities at the upper edge of the floodplain so that flooding and habitat restoration can be accomplished on the Refuge owned land in the floodplain.

Task C. *Breaching Flood Control Levees* - The USFWS will breach a COE project levee and former private levees (now USFWS owned)to allow future flood flows across fee-title Refuge lands. In some instances whole sections of private levees will be removed. Locations of breaches/removals will be based on potential breach sites identified by the COE in a 1998 non-structural flood control planning document. Earth moving will be accomplished using heavy equipment operated by USFWS (force account) and/or contract crews. An on-site archeological survey will be conducted and clearance obtained before any earth moving is initiated.

Task D. *Wetlands and Riparian Restoration* - This task will be coordinated by USFWS refuge staff and consists of multiple components including revegetating the floodplain with native trees, shrubs, and forbs; restoring historic wetland basins and slough channels; and controlling non-native invasive weeds. Work will be conducted by a combination of USFWS field crews and contractors. Wetlands will be restored by using heavy equipment to re-contour former basins and slough channels from the leveled agricultural fields. Water control structures will be installed where necessary and a water delivery system developed that accommodates pumped/delivered water during low-flow periods and floodwaters during high flow periods. Existing lift pumps and pipeline systems will be rehabilitated for use in management of wetlands and irrigation of riparian restoration sites. A five-year revegetation plan (Attachment A), including soil and community mapping was prepared as part of the pre-restoration planning funded by phase 1. During phase II a total of 812 acres of former agricultural fields will be planted to valley oaks, Fremont's cottonwood, black willow, arroyo willow, box elder, buttonwillow, elderberry, California rose, blackberry, and other native shrubs by a contractor (Sacramento River Partners [SRP]) using techniques described by Griggs (2000). These plantings will be irrigated and tended by SRP until successfully established. In addition, an effort will be made to re-colonize sites with native tree and shrubs by flooding those areas through use of the pipeline irrigation system left from the former agricultural operations. Control of non-native invasive weeds in the newly planted areas will be conducted by Sacramento River Partners as part of the revegetation contract. USFWS refuge staff will control non-native invasive weeds in other areas (approximately 300 acres) through a combination of herbicide application, mechanical removal, prescribed burning, and grazing. Control efforts will focus on removal of arundo, non-native trees, perennial pepperweed, yellow star-thistle, and poison hemlock.

Task E. *Re-introduction of Riparian Brush Rabbit* - The re-introduction of riparian brush rabbits onto refuge lands will be conducted as a collaborative pilot effort by the USFWS refuge staff, USFWS Sacramento Endangered Species Office, and the Endangered Species Recovery Program (ESRP) with funding support by the Bureau of Reclamation. The re-establishments of riparian brush rabbit populations into new sites is considered a critical component of the recovery plan of the species (USFWS 1998) and the floodplain of the San Joaquin River was specifically identified as a translocation site in that plan. To accomplish this task, temporary holding pens will be constructed in existing suitable riparian habitat, and ESRP personnel will move riparian brush rabbits (approximately 25) from a captive rearing facility to the site. The re-introduction effort will use a soft-release technique by which the rabbits will be placed in the temporary holding pen until acclimatized to the site; then the gate opened to allow the rabbits to move in and out of the pen; and the pen then ultimately removed after the rabbits have dispersed into the existing habitat. This process will be intensively monitored by ESRP personnel (see Task F). In preparation to these activities, USFWS refuge staff will use earth-moving equipment to widen selected locations on the existing levees into one-fourth to one-half acre islands (using material from the levee breaching/removal). These islands are necessary to provide a dry ground refugia for riparian brush rabbits during extreme flood events. These newly created islands will be planted to California rose, blackberry and other native shrubs to provide hiding and escape cover.

Task F. *Monitoring and Evaluations* - Project performance and biotic response will be measured through a multi-faceted monitoring and evaluation program. The USFWS will monitor the implementation of the project tasks, wetlands restoration, increase in shaded riverine aquatic habitat, and floodplain hydrology. SRP will monitor the riparian restoration. Researchers from ESRP will monitor the riparian brush rabbit re-introduction attempt. PRBO and the USFWS will jointly evaluate avian response. Additional information of the monitoring and evaluation program is detailed in section 2c. Monitoring and Assessment Plans.

c. Monitoring and Assessment Plans

The project partners will jointly develop a monitoring program that quantifies the short-term success of the project (3 years) yet meets multiple long term objectives (Table 1). SRP will use protocols outlined in the pre-restoration planning document (Griggs 2000) to monitor success and associated parameters of the riparian plantings, PRBO and USFWS will jointly conduct avian population monitoring using methods described by Ralph et al. (1993). ESRP will conduct the monitoring associated with the riparian brush rabbit re-introduction. USFWS refuge staff will monitor over-all project implementation; and frequency, extent, and duration of flood flows across the floodplain. Elements of the proposed monitoring are detailed on Table 1.

All monitoring and evaluation by project partners will be summarized in periodic reports and submitted to USFWS. These reports will then be shared among project partners so that the information can be used to make any necessary modifications to ongoing restoration activities and help design the future restation plans.

Monitoring of riverine processes, anadromous fish population and their immediate habitat (other than shaded riverine aquatic) will not be specifically monitored as part of this project. The USFWS Anadromous Fish Restoration Program (AFRP) in coordination with the refuge staff is conducting a net benefits assessment to evaluate impacts of this project to anadromous fish populations. A companion, aquatic resource monitoring proposal which the Refuge supports is being submitted to CALFED as a separate project.

The nature of habitat restoration and time span required for tree establishment dictate that monitoring of success and impacts to wildlife communities be of a long term nature (beyond the scope of this 3-year project performance period). The USFWS will request funding to continue established monitoring as part of subsequent phases of this project.

d. Data Storage and Handling

Data entry, analysis, and storage of the individual monitoring components will be handled by the project partner that has the lead on the specific monitoring task. Planting, survival, and other data will maintained by SRP on computer in Microsoft Excel worksheets at the SRP office in Chico, California. Avian monitoring data will be maintained by PRBO in computer files using formats and protocols detailed in Ralph et al. (1993) and Nur et al. (1999). Data associated with the riparian brush rabbit re-introduction will be maintained in computer files by ESRP. Project progress and monitoring data collected by USFWS refuge staff will be stored in computer files and worksheets at the San Luis NWR Complex office in Los Banos, California.

In addition, progress reports with summary data and findings will be prepared by SRP, PRBO, and ESRP, and then submitted to the USFWS. These reports will be archived and available to the public at the San Luis NWR Complex office.

Table 1. Monitoring and Data Collection for Phase II of the San Joaquin River NWR Riparian Habitat Protection and Floodplain Restoration Project.

Questions to be Evaluated	Monitoring Parameters and Data Collection	Data Evaluation Approach	Lead
Implementation success	Initiation and completeness of tasks	Time line is followed	USFWS
Restoration of native riparian vegetation	Survival, growth, and a density of each species	Comparison by soil type and topogeorgraphic position	SRP
Reduction in dominance by non-native species	Cover by weed species	Changes over time	SRP (planting sites) USFWS (other)
Restoration of shaded riverine aquatic habitat	Linear cover by vegetation along bank	Comparison of percent vegetated versus pre-project conclusion	SRP
Increase in neo-tropical bird populations	Point counts, nest surveys, and mist netting	Number of species	PRBO/USFWS
Effectiveness of natural vs cultivated restoration	Tree survival, density, and diversity; microtus densities	Comparison of data between active and passive restoration sites	SRP/USFWS
Success of brush rabbit re-introductions	Percent survival, dispersal, recruitment	Population level over time	ESRP/USFWS
Re-establishment of flood flows across floodplain	Frequency, extent, timing, and duration of flooding.	Events over time	USFWS

e. Expected Products/Outcomes If fully funded, the proposed project will preserve 17.7 miles of existing riparian corridor along the San Joaquin River, adjacent oxbows, and a portion of the lower Tuolumne River, and restore about 3,600 acres of riparian forest and seasonal wetlands. The fee title acquisitions and their subsequent management as part of the San Joaquin River NWR will allow widening of the floodplain, re-establishment of riparian forest and shaded riverine aquatic habitat, and restoration of wetland basins and slough channels. The acquisition of perpetual conservation easements will preserve existing riparian habitat, grasslands, wetlands, and croplands, and will preclude future subdivision and development. These action will directly benefit Federal and State listed species including Aleutian Canada goose, riparian brush rabbit, riparian wood rat, greater sandhill crane, western yellow-billed cuckoo, Swainson's hawk, valley elderberry longhorn beetle, Sacramento splittail, and San Joaquin tributaries fall-run chinook salmon. In addition, shorebirds, waterfowl, herons, neotropical migratory birds, and riparian/wetlands associated wildlife will benefit from restoration, protection, and management actions.

An additional benefit will be reduction in flood peaks, as water will be stored temporarily in offstream areas. Non-ecosystem objectives of flood protection are incrementally benefitted from this project. Water quality will be enhanced by the restored vegetated flood plain by providing sediment traps and nutrient uptake. Additional environmental and flood control benefits accrue from reduced need for dredging, clearing and snagging operations, and levee maintenance. Water supply needs will be reduced by the decreased need for irrigation.

Specific products and benefits from Phase II will include acquisition of easement lands that will be managed to benefit Aleutian Canada geese (Fed.-threatened), greater sandhill cranes (State-threatened), and other migratory birds; provision of nonstructural flood control through easements; removal of flood control levees to allow re-establishment of hydrologic functions across a much broadened floodplain; restoration of 812 acres of riparian habitat; restoration of 330 acres of wetlands; the re-establishment of a population of riparian brush rabbits back into suitable habitat (if successful); and an evaluation of restoration techniques and efforts on the biotic community to help guide future restoration efforts here and elsewhere.

f. Work Schedule

Task A: Acquisition of the conservation easement, from one willing seller will obtained by Dec. 2002

Task B: Flowage easements will be obtained, and the ring levee constructed by the COE by Dec 2001.

Task C: Breaching project levees to restore hydrologic function will be completed by Dec 2002.

Task D: Habitat restoration will occur during each of the next three years. Site preparation, plantings, and earthwork will be concentrated in the first two years (2001 & 2002).

Task E: Re-introduction activities will begin summer 2001 and continue through the duration of this project.

Task F: Monitoring and evaluation of success will begin during summer 2001 and continue through the third year of the project. A final monitoring report and project evaluation will be distributed December 2003.

g. Feasibility This project has a high certainty of success and can be implemented as soon as funding becomes available. Environmental assessments for land acquisition within the project area have already been completed as part of the ongoing refuge land acquisition program. Any NEPA compliance documents required for levee removal or restoration activities will be prepared by USFWS refuge staff who have experience in completing such documents for previous projects. Pertinent information associated with, and ability of project partners to complete the component tasks are detailed below:

Land Acquisition (Easements) - The USFWS Sacramento Realty Office has acquired property for the 10 major National Wildlife Refuges in California. Since its establishment in 1992, the Office has acquired over 189,237 acres in fee or easement. The Office presently has a staff of six highly qualified specialists with a combined experience of over 100 years in the areas of reality, appraisal, and environmental protection.

Flood Control Easements and Breaching the Levees - The COE prepared a Project Information Report in 1997 and selected the non-structural flood control alternative over repairing the existing project levee. Through this process, they are committed to securing flood control easements on the few landowners who would be affected. Initial contact has been made with affected landowners. A Memorandum of Understanding between the COE and USFWS regarding the breaching and subsequent management of the project levee is currently being prepared.

Habitat Restoration - The USFWS staff at the San Luis NWR Complex have a long track record in completing wetland and riparian restoration through both force-account crews and contractors. Current refuge staff, in addition to many smaller projects, have successfully completed three North American Wetlands Conservation Act restoration projects involving 7,020 acres and totaling over $6,645,800 in project costs since 1993. Personnel of SRP have a high level of expertise in the ecological principles and applied field techniques of restoration ecology. Since its incorporation in 1998, SRP has successfully re-established 448 acres of riparian habitat in the Sacramento Valley and is currently conducting other restoration projects.

Riparian Brush Rabbit Re-introduction - Any re-introduction of an endangered species onto its former range poses a certain level of scientific uncertainty. However, the USFWS, by agency mandate, is committed to the successful recovery of the riparian brush rabbit. Research personnel of ESRP, who will be leading the re-introduction effort, have been conducting field studies on riparian brush rabbits, including capture and handling, for the Department of Interior for over seven years and are recognized as authorities on the species. Re-introduction onto the San Joaquin River NWR has been identified as a component of the recovery plan and has the full support of the USFWS and BOR.

Monitoring and Evaluation - The San Luis NWR Complex staff includes professional biologists who have conducted field research and produced peer reviewed publications. Staff of SRP have successfully conducted monitoring and evaluation as part of their previous riparian restoration projects. Staff of Point Reyes Bird Observatory have a long record of demonstrated expertise in monitoring avian populations and are recognized as authorities in avian ecology. Research staff of ESRP routinely collect monitoring data as part of their ongoing studies on the riparian brush rabbit.

D. APPLICABILITY TO CALFED ERP GOALS AND IMPLEMENTATION PLAN AND CVPIA PRIORITIES

1. ERP Goals and CVPIA Priorities

This project directly addresses all six of the ERP Goals (CALFED 2000)

Goal 1 - At Risk Species

a) Increases shaded riverine aquatic habitat for fall-run Chinook Salmon (Fed-threatened) and Sacramento Splittail (Fed-threatened).
b) Re-establishes a population of riparian brush rabbit (Fed-endangered) into former range, and enhances habitat.
c) Enhances and restores habitat for riparian dependent species such riparian woodrat (Fed-endangered), valley elderberry longhorn beetle (Fed-threatened), yellow-billed cuckoo (State-endangered), and Swainsons hawk (State-threatened).
d) Protects winter foraging habitat for Aleutian Canada goose (Fed-threatened) and greater sandhill crane (State-threatened).

Goal 2 - Ecosystem Processes and Biotic Communities

a) Breaching and removal of flood control levees will allow over-bank flooding of the floodplain to occur. Floodplain hydrology will be restored and will sustain the riparian forest and the associated wildlife communities.

Goal 3 - Harvestable Species

a) Floodplain and riparian habitat restoration, and protection of cropland foraging habitat to accomplish goals 1 and 2 will also maintain and enhance migratory bird species that are subject to sport harvest. Local nesting population of wood ducks and mallards will benefit from riparian and wetland restoration. Species of ducks and geese that winter in or migrate through the area will benefit from increased wetlands and preserved foraging areas.

Goal 4 - Habitats

a) Restoration of riparian forest, seasonal wetlands, and shaded riparian aquatic habitat is a major component of this proposal.

Goal 5 - Non-Native Invasive Species

a) Aggressive actions to reduce established non-native species will be an integral part of the restoration effort. These will focus on invasive weeds in the planting sites and arundo, perennial pepperweed, and yellow-star-thistle elsewhere.

Goal 6 - Sediment and Water Quality

a) Elimination of agricultural cropping and dairy operations in the floodplain project will reduce direct inputs of pesticides, nitrate leaching from dairy wastes, and sediments from the project site into the San Joaquin River.
b) Development of wetlands and riparian habitat will provide a natural filter to reduce pesticide resides and sediments inputs from upslope of the project site.

2. Relationship to Other Ecosystem Restoration Projects

The San Joaquin River NWR riparian habitat protection and floodplain restoration proposal builds on existing conservation programs and is closely linked to the following projects:

a) USFWS - Establishment of San Joaquin River NWR in 1987 and ongoing process to complete acquisition within approved boundary.

b) USFWS - Anadromous Fish Restoration Program - initiative aimed at restoring salmon and other anadromous fish populations in the Central valley rivers. It is funded through CVPIA. The Stockton Office of this program acquired 30 acres of land in 1999 along the Stanislaus River (3.5 miles from project site) to protect riparian and shaded riverine aquatic habitats and transferred that land to the San Joaquin River NWR. That office has funded a contractor ($50,000) to conduct a net benefits assessment to evaluate the effects of this project (San Joaquin River NWR Riparian Habitat Protection and Floodplain Restoration Project) on anadromous fish populations along this stretch of the San Joaquin River.
c) USFWS - Draft Comprehensive Conservation Plan contains an alternative that proposes to expand the easement acquisition project boundary to include the San Joaquin River floodplain from the San Joaquin River NWR southward to the Grasslands Ecological Area in Merced County.
d) California Department of Fish and Game - Conservation easement on private duck clubs on the San Joaquin River floodplain near the town of Westley.
e) NRCS - Flood prone private lands along the San Joaquin, Stanislaus, and Tuolumne Rivers in Stanislaus County are being protected by conservation easements through the Wetland Reserve Program.
f) Grayson Ranch Project - Riparian restoration project on the Tuolumne River being conducted by the East Stanislaus Resource Conservation District and Friends of the Tuolumne through funding from CALFED (98-F07) and NRCS.

In addition, this proposal helps fulfill federal directives from the Council of Environmental Quality and the Office of Management and Budget, and helps meet numerous state and federal agency goals such as non-structural flood protection projects, the Governor's Flood Emergency Action Team (FEAT) report, the San Joaquin River Management Plan, CALFED Bay-Delta Program, North American Waterfowl Management Plan, Central Valley Habitat Joint Venture, Riparian Habitat Joint Venture, Aleutian Canada Goose Recovery Plan, and the multi-species Recovery Plan for Upland Species of the San Joaquin Valley, California.

3. Requests for Next-Phase Funding

As stated previously in the proposal, this application is for Phase II of a multi-phase project to protect riparian habitat and restore the floodplain at the San Joaquin River NWR. Phase I focused on fee-title and easement acquisitions in the 1997 flood zone, pre-restoration planning, biological inventory, and site clean-up. Phase II request funding for additional easement acquisition, breaching flood control levees, initiating wetlands and riparian restoration, supporting a riparian brush rabbit re-introductions effort, and monitoring and evaluations.

Phase III and IV will seek CALFED funding for additional riparian and wetlands restoration, support of the brush rabbit introduction effort, continued monitoring and evaluation, and public education/outreach facilities such as a visitor contact center, and information panels. Subject matter would include: natural history of the San Joaquin River, Pacific flyway, riparian woodland habitat, wetlands and associated wildlife and fisheries.

A description of Phase I and its status is provided in Appendix B.

4. Previous Recipients of CALFED or CVPIA Funding

The San Luis NWR Complex has been the recipient of two other CALFED grants.

97-B05 Feasibility Analysis for San Joaquin River - Bear Creek Floodplain Restoration Project - San Luis NWR, Merced County.

Status - A contract was let to Jones and Stokes Associates in 1998 to assess the hydrological and biological feasibility of restoring the floodplain of the San Joaquin River on San Luis NWR. A draft report has been submitted to the USFWS for review and a final report with recommendations is scheduled for June 2000. Submission of the report will complete the requirements of the funded proposal.

98-F21 Lower San Joaquin River Floodplain Protection and Restoration Project.

Status - A 230 acres tract of land containing riparian habitat and floodplain was purchased in fee-title during 2000 and

has been incorporated into the San Joaquin River NWR.

5. System-Wide Ecosystem Benefits

With protection and restoration, the project will be part of a mosaic of freshwater wetland, grassland, slough, and riparian habitats, that extend from the San Joaquin/Sacramento River Delta southward to the Grasslands Ecological Area of Merced County. The project directly contributes to the goal of linking these habitats into a protected floodplain corridor along the length of the lower San Joaquin River, specific benefits at a system-wide ecosystem level include the following:

a) Reduce fragmentation, increase vegetative cover, and increase the connectivity of the riparian corridor along the San Joaquin River.
b) Initiate riparian forest succession by re-establishing native tree and shrub species and by controlling non-native invasive species.
c) Improve water quality through creation of a filter strip between upslope agricultural fields (private) and the river.
d) Provide a forested area that is sufficiently larger (> 50-100 acres) to create air convection that will cool adjacent river water temperatures (CALFED 1999).
e) Provide critical habitat and conditions for anadromous fish, migratory birds, neotropical migratory landbirds, wetlands and riparian dependent wildlife, and other organisms.
f) Directly contribute to the recovery of riparian brush rabbits by providing re-introduction habitat and recovery of Aleutian Canada geese by protecting foraging and roost pond habitat.
g) Reduce downstream flood damage by widening the floodplain and allowing transient storage of floodwaters.

E. QUALIFICATIONS

Kim Forrest (Project Leader) is the project leader for the San Luis NWR Complex, responsible for planning , guiding, and administering a large and complex operation in accordance with established management plans, policies, and prescribed objectives. This includes formulating comprehensive plans for the various Refuge programs, developing Refuge policy, coordination of programs with various partners, directing operations and maintenance activities, and fiscal and personnel administration. Previous work experience includes 23 years with the USFWS; including as Project Leader of Humboldt Bay NWR (California), Deputy Project Leader for the Sacramento NWR Complex (California), and assistant refuge manager positions at San Luis NWR Complex, Charles M. Russell NWR Complex (Montana), and Fish Springs NWR (Utah).

Scott Frazer (Restoration Planning and Implementation) is refuge manager for San Joaquin River NWR, responsible for the routine logistic and operational needs of the 6,000 acre refuge. Frazer has 22 years of professional natural resource management experience with specialized experience in erosion control, plant propagation, intensive wetlands management and large habitat restoration projects. He is the primary technical coordinator for innovative "non-structural" flood management proposals on the refuge complex. Previous work experience includes 14 years with Soil Conservation Service (California and Oregon), 8 years with the USFWS as Assistant Refuge Manager Kesterson NWR, Deputy Project Leader and Refuge Operations Specialist at San Luis NWR Complex (California). Mr. Frazer received a B. S. in Wildlife Biology from Humboldt State University in 1979.

Dennis Woolington (Restoration Planning, Monitoring, Evaluation) is a Supervisory Wildlife Biologist at the San Luis NWR Complex. He serves as a staff advisor to the project leader on biological and management issues, and oversees the biological program on three National Wildlife Refuge totaling more than 37,000 acres. Mr. Woolington's responsibilities include developing and overseeing operational surveys and monitoring efforts; coordinating research, designing and obtaining funding for major habitat restoration projects, implementing riparian restoration efforts, and preparing National Environmental Policy Act documents and Section 7 Consultations. He has 25 years of professional resources management experience which includes 2 years with the Indiana Dept. of Natural Resources; 6 years with USDA Forest Service (Oregon); and 17 years with the USFWS at the Aleutian Islands NWR (Alaska), National Wetlands Research Center (Louisiana) and the San Luis NWR Complex (California). Mr. Woolington received a B.S. in Wildlife Sciences from Purdue University in 1974, and a M.S. in Wildlife Management from Humboldt State University in 1980.

Howard Stark (Land Acquisition) is Chief of the USFWS Sacramento Realty Office. He manages the acquisition program which ranges from $7-40 million annually throughout the California Central Valley and San Francisco Bay Area. He has over 11 years of federal agency experience as a Supervisory Realty Specialist, Appraiser, Office Manager, and Environmental Planner.

SRP (Riparian Restoration) is a non-profit organization dedicated to the protection and restoration of natural resources of the Central Valley. It is composed of a team of experienced professionals with expertise in biotic principles and applied field techniques of restoration ecology. The group has a proven track record for implementing cost effective restoration. Since its incorporation in 1998, it has restored 448 acres of riparian habitat for Federal, State, and County clients. John Carlon will oversee the SRP riparian restoration activities for this project. He has 7 years experience with riparian restoration in Central California; 5 years as Program manager for the nature Conservancy's Sacramento River Project and 2 years as Project Director for SRP. Mr. Carlon obtained a B.S. in Agronomy and Horticulture from C.S.U., Chico and a M.S. in International Agriculture Development from C.S.U. San Luis Obispo.

PRBO (Avian Monitoring) is a non-profit organization, that since its establishment in 1965 has been dedicated to the conservation of birds and preservation of the natural communities on which they depend. It maintains a permanent research station in Marin County and conducts avian monitoring research throughout the state in conjunction with Federal, State, and private partners. PRBO is internationally recognized as a center of excellence for avian research and a leader in bird conservation initiatives. Geoff Geupel, Director of Terrestrial Programs will oversee PRBO's participation in the monitoring phase of this project. He has 20 years of professional experience in private sector bird conservation. Mr. Geupel co-authored a handbook that has standardized field techniques for monitoring of neo-tropical migratory landbirds. He has authored/co-authored over 30 peer-reviewed publications on bird resources/conservation topics. Mr. Geupel received a B.S. in Biology from Lewis and Clark College, Washington.

ESRP (Riparian Brush Rabbit Re-introduction) is a cooperative program of the USFWS and BOR administered by C.S.U. Stanislaus, Stanislaus Foundation. It consists of a team of biologists whose mission is to conduct field research, compile life history data, and conduct management activities that aid in the recovery of San Joaquin Valley species that are listed under the federal Endangered Species Act. ESRP produced a multi-species Recovery Plan for Upland Species of the San Joaquin Valley, California for the USFWS in 1998. Dan Williams, PhD is the Coordinator for ESRP and will lead the re-introduction activities. Dr. Williams is a professor at C.S.U. Stanislaus and has directed the ESRP research and monitoring of the riparian brush rabbit for the past 7 years.

F. COST

1. Budget - The budget for phase II of this project is displayed on Table 2. Elements on the budget and cost breakdowns are detailed below:

Phase II salary needs for USFWS personnel total $367,000. Salaries of permanent employees ($87,000 total) will be paid through USFWS funds as a cost sharing to this project. USFWS will hire four employees, whose time will be directed solely to this project, on two-year term appointments to be paid through CALFED funds. Salary rates by position and grade are presented below:

GS- 5 Biological Technician (term)	$ 652 per week
GS- 9 Wildlife Biologist (term)	$ 748 per week
GS-12 Wildlife Biologist (permanent)	$1,434 per week
GS-12 Refuge Manager (permanent)	$1,434 per week
WG-4 Laborer (term)	$ 527 per week
WG-8 Maintenance Worker (term)	$ 652 per week

USFWS personnel will directly participate in completing Tasks A - F. Salary costs detailed on Table 2 and below are prorated for each task by the percentage of time anticipated necessary to complete the tasks.

Task A. Obtaining conservation easement protection of one landowner will require $50,000 in USFWS staff costs for realty specialists, easement biologists, surveyors and administrative specialists. General administrative overhead costs calculated at a reduced rate of 3% total $60,000. Flood easement acquisition costs are estimated to be $2,000,000. Other title policy and closing costs are projected to be $15,000.

Task B. Construction of ring levees and acquisition of flood flowage easements will be conducted by the US Army Corp of Engineers (COE). The COE 1997 project information report obligates funding for these activities once a project agreement is signed. The construction costs are estimated to be $400,000. Land right acquisition costs for five adjacent landowners is estimated to be $1,000,000.

Task C. Breeching project levees will involve USFWS staff costs totaling $35,000 for planning, environmental compliance, and implementation of field work necessary to physically modify the existing levees. Refuge base budget allocations will cover $10,000 of refuge staff costs. General administrative overhead is calculated at a reduced rate of 3% for $25,000. Service contracts to obtain an archeology consultant ($65,000) and heavy equipment ($85,000) are estimated to cost $150,000. The archeologist will conduct work necessary to comply with the National Historical Policy Act, Native American Graves Protection and Repatriation Act and Archaeological Resources Act.

Task D. Habitat restoration will involve USFWS staff costs totaling $147,000 over the three year project. Anticipated base budget allocations will be utilized for $47,000 of refuge staff costs. A wildlife biologist (term appointment) will be hired to conduct environmental compliance, monitoring, logistical coordination and report preparation. Wage grade employees will conduct invasive species management, site clean up, maintain access roads and other facilities needed for project completion. General administrative overhead is calculated at a reduced rate of 3% for $156,000. Contract services will be utilized to direct and implement restoration plantings as well as earth moving. Sacramento River Partners have been identified as a qualified subcontractor with expertise and willingness to accomplish 812 acres of direct planting and all related tasks at a cost of $4,344,983. Earth moving will be necessary to avoid entrapment of migrating fish in abandoned ditches, for wetland basin development and to remove abandoned agricultural facilities. Earth moving costs are estimated to be $400,000. Materials and other direct costs of $150,000 will be utilized for fuel, other consumable supplies, water control structures, pump stations, and repair or maintenance of facilities and infrastructure. Total costs for habitat restoration elements is estimated to be $5,197,983.

Task E. Reintroduction of riparian brush rabbits will involve a service contract of $360,000 between the BOR and ESRP. ESRP staff specialists will conduct census, trapping, monitoring and other specialized services required to handle listed species. USFWS staff time totaling $2,000 will be needed for coordination and overseeing habitat improvements. Additionally, $100,000 in service contracts and $50,000 in materials costs will be applied to habitat restoration to enhance site characteristics that contribute to riparian brush rabbit survival. General administrative overhead calculated at the reduced rate of 3% totals $4,500.

Task F. Monitoring and evaluation of project accomplishments is projected to have USFWS salary costs of $133,000. General administrative costs of $8,250 are calculated at a reduced rate of 3%. Service contracts in the amount of $88,000 will be used to retain Point Reyes Bird Observatory biologists to conduct multiple year field census and report preparation. Materials costs of $50,000 will pay for equipment and consumables needed for the project.

Total project cost is estimated at $9,256,733. Of that, $7,646,233 is requested as CALFED Bay-Delta Program funds.

2. Cost-Sharing - A total of $1,885,000 will be contributed by three partners as cost sharing. The COE has committed fund for flood easements and construction of a ring levee as part of their selection of a non-structural flood control alternative. The USFWS and BOR funding levels have been set by agency staff based on base budgets, continuation of past project funding (i.e., previous BOR funding for ESRP), and resource priorities.

USFWS	$ 125,000	($67,000 refuge salaries, $20,000 Realty Salaries, $38,000 Region 1 Nongame funds)
COE	$1,400,000	($1,000,000 flood easement acquisitions, $400,000 construction of ring levee)
BOR	$ 360, 000	(Support of ESRP and brush rabbit re-introduction)

Table 2. Budget Costs

Project Task	Direct Salary and Benefit Costs	Indirect Costs (Gen. Admin)	Service Contracts	Estimated Acquisition Cost	Materials & Other direct costs	Total Cost
Task A Easement Acquisition	$30,000 (CALFED) 20,000 (FWS)	$60,000 (CALFED)		$2,000,000 (CALFED)	15,000 (CALFED)	$2,105,000 (CALFED) $ 20,000 (FWS)
Task B; Ring Levee Flood Easements,			$400,000 (COE)	$1,000,000 (COE)		$1,400,000 (COE)
Task C; Breech Project Levees	$25,000 (CALFED) $10,000 (FWS)	$25,000 (CALFED)	$150,000 (CALFED)			$200,000 (CALFED) $10,000 (FWS)
Task D; Habitat Restoration	$100,000(CALFED) $ 47,000 (FWS)	$156,000 (CALFED)	$4,744,983 (CALFED)		$150,000 (CALFED)	$5,150,983 (CALFED) $47,000 (FWS)
Task E; Reintroduction of Riparian Brush Rabbit	$2,000 (FWS)	S4,500 (CALFED)	$100,000 (CALFED) $360,000 (BOR)		$50,000 (CALFED)	$154,500 (CALFED) $360,000 (BOR) $2,000 (FWS)
Task F; Monitoring and Evaluation	$125,000 (CALFED) $8,000 (FWS)	$8,250 (CALFED)	$50,000 (CALFED) $38,000 (FWS)		$50,000 (CALFED)	$233,250 (CALFED) $46,000 (FWS)

Partners Contribution	$ 1,610,500
CALFED Grant Request	$ 7,646,233
Grand Total	$9,256,733

Participants

CALFED = CALFED Bay Delta Program
FWS = U.S. Fish and Wildlife Service
COE = U.S. Army Corps of Engineers
BOR = U.S. Bureau of Reclamation

G. LOCAL INVOLVEMENT

USFWS staff are hosting quarterly "Community Forums" as part of the refuge Comprehensive Conservation Planning process. Discussions address the full range of Refuge management issues, including land acquisition, habitat restoration, comprehensive planning and specific topics of interest to participants. Public meeting notices, a direct mailing list in excess of 400 people and periodic "Refuge Update" newsletter style publications have been used to inform neighbors, stakeholders and agencies of actions being considered for the Refuge.

Recently several local conservation groups and non-governmental organizations have been given guided tours of the Refuge. Periodic field trips and on site meetings with numerous governmental agencies are conducted to coordinate management activities.

The Stanislaus County Farm Bureau has expressed concerns about land being withdrawn from agricultural production to accomplish the habitat restoration objectives of this project. Some adjacent landowners have asked Refuge managers to modify habitat management activities to address specific concerns. The Refuge expansion environmental assessment (EA) makes specific commitments to accept agricultural tail water.

The Refuge is working closely with the US Army Corp of Engineers to identify the potential for third party impacts from this project. A commitment by both federal agencies to pursue acquisition of flowage easements from adjacent landowners would compensate landowners in advance for projected future impacts.

Information regarding project proposals has been provided to Mr. Ron Freitas, Planning Director with Stanislaus County as well as the Stanislaus County Clerk (see Attachment C and D).

H. COMPLIANCE WITH STANDARD TERMS AND CONDITIONS

The Fish and Wildlife Service (Service) cannot agree to a standard clause requested for State funded projects. Attachment D, Terms and Conditions for State Proposition 204 Funds, Section 3, states "Performance Retention: Disbursement shall be made on the basis of costs incurred to date, less ten percent of the total invoice amount. Disbursement of the ten percent retention shall be made either: (1) upon the Grantee's satisfactory completion of a discrete project task (ten percent retention for task will be reimbursed); or (2) upon completion of the project and Grantee's compliance with project closure requirements specified by CALFED (ten percent retention for entire project will be disbursed)".

The Service's authorization to enter into agreements with no Federal entities was changed in FY2000. Our FY2000 Appropriations bill authorizes the Service to enter into contracts with State agencies when advance payment to the Service is not possible. In accordance with the requirements imposed by Congress in the FY2000 Appropriations bill and report language, the Service's Director must approve a project when advance payment is not possible and certify that payments will be made in full by the State within 90 days after the Service issues an invoice.

Specifically, the ten percent retention clause cannot allow timely payments for the following reasons:

In our Federal Financial System (FFS) accounting program, a periodic invoice (either quarterly or monthly depending on the terms of the contract) is automatically issued form our finance center based on actual expendiutres of the Service on a project. Invoices include a payment due date on the invoice and when payment is not received in full by that due date, the system automatically shows the unpaid balance as delinquent. Depending on how delinquent the payment is, interest, penalty and administrative charges may also accrue. With ten percent retention withheld on each invoice, the ten percent retention amount then causes applicable invoice record in FFS to be partly delinquent and remain delinquent until the project or individual tasks identified in the contract are completed and the retention is released.

The Service's Finance Center must report to the Department of Treasury if the Service is owed funds by any entity. Therefore, when accounts remain delinquent due to the ten percent retention of payments owed the Service, that delinquency continues to be reported to Treasury.

The Service has previously entered into agreements with the State of California that do not contain the ten percent retention clause.

We have asked the States Deputy Attorney General to provide clarifying guidance to the Department of Water Resources that is general in scope, which can also be applied to contracts related to the CALFED program.

Our offices will continue to work with the State closely on State funded projects. If the State is not satisfied with the work performed by the Service, the State project manager should contact the Service's project manager to correct the performance problem. If needed, upon notification interim billings can be canceled until the State is satisfied with the Service's performance.

We can comply with all other State and Federal standard clauses.

I. LITERATURE CITED

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Nur, N., S.L. Jones, and G.R. Geupel. 1999. A statistical guide to data analysis of avian monitoring programs. Biological Technical Publication BTR-R6001-1999. Fish and Wildlife Service, U.S. Department of Interior. Washington, D.C. 46pp

The Nature Conservancy. 1998. Sacramento River project, riparian forest restoration manual. Sacramento, CA.

Ralph, C.J., G.R. Geupel, P. Pyle, T.E. Martin, and D.F. DeSante. 1993. Handbook of fields methods for monitoring landbirds. Gen. Tech. Rep. PSW-GTR-144. Pacific Southwest Research Station. Forest Service, U.S. Department of Agriculture. Albany, CA. 41pp.

U.S. Fish and Wildlife Service. 1998. Recovery plan for upland species of the San Joaquin Valley, California. Region 1, Portland OR. 319 pp.

J. THRESHOLD REQUIREMENTS

Local notification letters are attachments "C" and "D".
Land use checklist is attachment "E".
Environmental Compliance checklist is attachment "F".

San Joaquin River NWR
CalFed PSP - Attachment B

Project Title: SAN JOAQUIN RIVER NATIONAL WILDLIFE REFUGE RIPARIAN HABITAT PROTECTION AND FLOODPLAIN RESTORATION PROJECT - PHASE 1

Applicant Name: U.S. Fish and Wildlife Service, Sacramento Realty Office on behalf of San Joaquin River National Wildlife Refuge

Project Description and Primary Biological/Ecological Objectives. The U.S. Fish and Wildlife Service (USFWS) requested a total of $10,647,000 to help fund phase 1 of a project that will provide long term preservation and protection, and restoration of 6,169 acres of fish and wildlife habitat on and adjacent to the San Joaquin River National Wildlife Refuge (NWR) boundaries. Project partners include the U.S. Army Corps of Engineers, Natural Resources Conservation Service, California Department of Water Resources, and numerous other agencies on portions of this proposed acquisition. Total project cost for phase1, including partner contributions, was $20,647,000.

The objective of the proposal is to acquire lands and restore riparian and other wetland habitats along the San Joaquin River for the benefit of numerous listed and special status species including Aleutian Canada goose, greater sandhill cranes, western yellow-billed cuckoos, Swainson's hawk, riparian brush rabbit, riparian wood rat, valley elderberry longhorn beetle, Sacramento splittail, and San Joaquin tributaries fall-run chinook salmon. In addition, shorebirds, waterfowl, herons, neotropical migratory landbirds, and other riparian/wetlands dependent wildlife will benefit from restoration and protection actions.

The proposed fee title acquisitions and management will allow widening of the flood plain, provide transient storage of flood waters, facilitate ground water recharge, and allow riparian and wetland habitat restoration thus accomplishing a measure of downstream non-structural flood protection, as well as water quality, wildlife and fisheries benefits. The proposed conservation easement will perpetually preserve considerable existing riparian habitat, grassland, wetlands, croplands and will preclude subdivision and development.

Hypothesis No working hypothesis were developed for Phase 1 of this project because actions focus on land acquisition, biological inventory, and site cleanup. The overall project revolves around the primary hypothesis that returning flood flows back to, and restoring 3,200 acres of flood prone agricultural land back to riparian and wetlands habitat will increase species richness and diversity of plants and wildlife and re-establish a functional riparian community on that floodplain.

Tasks. The proposed project encompasses several components in three distinct phases. This proposal sought CALFED funding only for Phase I which included:

Task A. Acquisition in fee title of 3,112 acres of San Joaquin River flood plain from three willing sellers on the west side of the river (See Figure 1 in the proposal);
Task B. Acquisition in fee title of San Joaquin River (540 ac.) flood plain corridor (east side of the river) from one willing seller;
Task C. Acquisition in fee title of Riley Slough (553 ac.) flood plain corridor (east side of the river) from one willing seller;
Task D. Acquisition of a conservation easement on 1,964 ac. from one willing seller east of the river, and habitat development and wildlife management consultation;
Task E. Site clean up at the fee-title acquisitions
Task F. Flood plain habitat restoration planning and engineering studies.

Current Status

Task A. Fee title acquisitions completed in 1999.
Task B. Acquisition is pending. Final sale is tied to completion of Task C (same landowner). Appraisal process is near completion and negotiations are underway with landowner. Completion anticipated summer 2000.
Task C. Acquisition is pending. Former willing seller changed from wanting to sell in fee-title to selling only a perpetual conservation easement. Negotiations over conditions of perpetual conservation easement are nearing completion. Appraisal process is near completion. Completion of acquisition is anticipated summer of 2000
Task D. Acquisition is pending. Negotiations over conditions of perpetual conservation easement are nearing completion as is the appraisal. Completion of acquisition is anticipated as summer 2000.
Task E. Funded site cleanup has been completed.
Task F. A one year biological inventory was completed by USFWS in 1999. A floodplain restoration plan and revegetation plan was prepared by Sacramento River Partners January 7, 2000.

Existing Data. The nature of Phase I precluded any monitoring program. The USFWS has submitted quarterly reports to the CALFED Bay-Delta Program throughout the duration of Phase I . The USFWS biological inventory was compiled as a report and submitted to CALFED. The floodplain restoration plan was submitted to USFWS and is being used to guide restoration for Phase II. Both documents are available at the San Luis NWR Complex Office in Los Banos, California.

San Joaquin River NWR
CalFed PSP - Attachment C

United States Department of the Interior

FISH AND WILDLIFE SERVICE
San Luis National Wildlife Refuge Complex
P.O. Box 2176
Los Banos, CA 93635
(209) 826-3508 ~ Fax (209) 826-1445

May 5, 2000

Mr. Ron Freitas
Planning Director
Stanislaus Co. Planning Dept.
1010 Tenth St., Suite 3400
Modesto, Calif. 95354

Dear Ron:

Enclosed are the materials that we discussed by phone today. The March 1998 environmental assessment was prepared when we expanded the refuge boundary to acquire flood prone lands inundated by the 1997 flood. If you are available on the morning of May 16, 2000, I would enjoy the opportunity to discuss our Comprehensive Conservation Plan that is in progress as well as the CalFed riparian habitat restoration project proposal.

You had inquired about the financial impact to Stanislaus County of in lieu of tax payments. Also enclosed are cover letters sent to the County Treasurer at the time that revenue sharing payments were made for the past two years.

Please feel free to call upon me at any time that you have an interest in current San Joaquin River NWR management activities or future plans.

Sincerely,

Scott E. Frazer
Refuge Operations Specialist

San Joaquin River NWR
CalFed PSP - Attachment D

United States Department of the Interior

FISH AND WILDLIFE SERVICE
San Luis National Wildlife Refuge Complex
P.O. Box 2176
Los Banos, CA 93635
(209) 826-3508 ~ Fax (209) 826-1445

May 12, 2000

Karen Mathews
Stanislaus County Clerk
P. O. Box 1670
1021 "I" St.
Modesto, California 95353

Dear Ms. Mathews:

Enclosed is a copy of the San Joaquin River National Wildlife Refuge (NWR) CalFed Ecosystem Restoration Program proposal, with attachments, for 2001. These materials have been submitted to CalFed requesting funds to implement riparian habitat restoration work on the Refuge. The proposal is submitted to you to inform the Stanislaus County Board of Supervisors of our proposal and involve interested individuals in planning and implementing future projects.

If you would like any additional information on Refuge activities, please contact me at the address or phone number above.

Sincerely,

Scott E. Frazer
Refuge Operations Specialist

10. Will the applicant acquire any interest in land under the proposal (fee title or a conservation easement)?

X
YES

NO

11. What entity/organization will hold the interest? U.S.F.W.S.

12. If YES to #10, answer the following:

Total number of acres to be acquired under proposal	
Number of acres to be acquired in fee	
Number of acres to be subject to conservation easement	3,185 acres

13. For all proposals involving physical changes to the land or restriction in land use, describe what entity or organization will:

manage the property	U.S.F.W.S.
provide operations and maintenance services	U.S.F.W.S.
conduct monitoring	U.S.F.W.S. and contractor (i.e., PRBO)

14. For land acquisitions (fee title or easements), will existing water rights also be acquired?

* X
YES

NO

(* Riparian rights accompany land. Modesto Irrigation District service on some portions.)

15. Does the applicant propose any modifications to the water right or change in the delivery of the water?

YES

X
NO

16. If YES to #15, describe: n/a

Land Use Checklist

All applicants must fill out this Land Use Checklist for their proposal. Applications must contain answers to the following questions to be responsive and to be considered for funding. *Failure to answer these questions and include them with the application will result in the application being considered nonresponsive and not considered for funding.*

1. Do the actions in the proposal involve physical changes to the land (i.e. grading, planting vegetation, or breeching levees) or restrictions in land use (i.e. conservation easement or placement of land in a wildlife refuge)?

   X — YES ____ NO

2. If NO to #1, explain what type of actions are involved in the proposal (i.e., research only, planning only). n/a

3. If YES to #1, what is the proposed land use change or restriction under the proposal?

   Fallow agricultural fields inundated by the 1997 flood event will be dedicated riparian habitat and managed as a unit of the San Joaquin River NWR. Project flood control levees will be breeched as recommended by US COE (Army Corps of Engineers).

4. If YES to #1, is the land currently under a Williamson Act contract?

   ____ YES X NO

5. If YES to #1, answer the following:

   Current land use: Fallow
   Current zoning: Agricultural
   Current general plan designation: Ag

6. If YES to #1, is the land classified as Prime Farmland, Farmland of Statewide Importance or Unique Farmland on the Department of Conservation Important Farmland Maps?

   ____ YES * X NO
   (* Not in published soil survey. USDA WR easements and flooding prevent this designation.)

7. If YES to #1, how many acres of land will be subject to physical change or land use restrictions under the proposal? ± 1,600 acres

8. If YES to #1, is the property currently being commercially farmed or grazed?

   ____ YES X NO

9. If YES to #8, what are the number of employees/acres _____. What are the total number of employees. _____ n/a

Environmental Compliance Checklist

All applicants must fill out this Environmental Compliance Checklist. Applications must contain answers to the following questions to be responsive and to be considered for funding. *Failure to answer these questions and include them with the application will result in the application being considered nonresponsive and not considered for funding.*

1. **Do any of the actions included in the proposal require compliance wit either the California Environmental Quality Act (CEQA), the national Environmental Policy Act (NEPA), or both?**

   X — YES

   _____ — NO

2. **If you answered yes to # 1, identify the lead governmental agency for CEQA/NEPA compliance.**

   U.S. Fish and Wildlife Service
   Lead Agency

3. **If you answered no to # 1, explain why CEQA/NEPA compliance is not required for the actions in the proposal.**

4. **If CEQA/NEPA compliance is required, describe how the project will comply with either or both of these laws. Describe where the project is in the compliance process and the expected date of completion.**

   Existing EA's cover most project components. A new EA will be prepared to address breeching levees.

5. **Will the applicant require access across public or private property that the applicant does not own to accomplish the activities in the proposal?**

   _____ YES

   X All land owned by Applicant — NO

   If yes, the applicant must attach written permission for access form the relevant property owner(s). Failure to include written permission for access may result in disqualification of the proposal during te review process. Research and monitoring filed projects for which specific filed locations may not been identified will be required to provide access needs and permission for access with 30 days of notification of approval.

6. Please indicate what permits or other approvals may be required for the activities contained in your proposal. Check all boxes that apply.

LOCAL		
Conditional use permit	None	
Variance	___	
Subdivision Map Act approval	___	
Grading permit	___	
General plan amendment		___
Specific plan approval	___	
Rezone		___
Williamson Act Contract cancellation	___	
Other _____ (please specify)	___	
None required	___	
STATE		
CESA Compliance	___	(CDFG)
Streambed alteration permit	___	(CDFG)
CWA § 401 certification	___	(RWQCB)
Coastal development permit	___	(Coastal Commission/BCDC)
Reclamation Board approval	Letter already on file	
Notification	___	
Other _____ (please specify)	___	
None required	___	
FEDERAL		
ESA Consultation	___	(USFWS)
Rivers & Harbors Act permit	___	(ACOE)
CWA § 404 permit	___	(ACOE)
Other _____ (please specify)	___	
None required	___	

DPC = Delta Protection Commission
CWA = Clean Water Act
CESA = California Endangered Species Act
USFWS = U.S. Fish and Wildlife Service
ACOE = U.S. Army Corps of Engineers

ESA = Endangered Species Act
CDFG = California Department of Fish and Game
RWQCB = Regional Water Quality Control Board
BCDC = Bay Conservation and Development Comm.

PRE-RESTORATION PLAN
FOR
WEST UNITS OF
THE SAN JOAQUIN RIVER
NATIONAL WILDLIFE REFUGE

Prepared by
Sacramento River Partners

Author
F. Thomas Griggs Ph.D.

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Executive Summary

This plan outlines the restoration of wildlife habitat on the Non-Structural Flood Protection Demonstration Project (3,166 acres) on the San Joaquin River National Wildlife Refuge. The restoration will be managed by the US Fish & Wildlife Service and will include the restoration of Upper and Lower White Lakes (549 acres) and the planting of native riparian trees and shrubs on 1,623 acres. In addition, a 100-acre food-plot for Aleutian Canada geese will be replanted each year. Existing riparian habitat occurs only on the riverside of the levees system (672 acres). The remaining 222 acres of agricultural infrastructure are excepted from this plan. The projected total project cost is $9,039,263.

Three riparian plant communities will be installed on the Refuge based upon soil features and local hydrology: Buttonbush-Valley willow scrub will be planted around the perimeter of the lakes; Mixed riparian forest will be planted at mid-elevations above the lakes; and Valley oak forest will be planted at the highest elevations on the refuge. Each will be planted with native understory sedges and grasses. The planting pattern in each field will be designed to accommodate target wildlife species: Riparian obligate avifauna, the riparian brush rabbit (listed), and the valley elderberry longhorn beetle (listed). The White Lakes will provide permanent wetland habitat to a wide variety of waterfowl and shorebirds. During winter and spring flooding, the Refuge will function as rearing habitat for juvenile salmon and steelhead, and as spawning habitat for the Sacramento Splittail.

The restoration area is divided into 52 agricultural fields. These fields will be restored in five separate phases. The plan proposes that one phase (average acreage: 324) be restored each year for five years. If allowable, farming field crops ahead of the restoration process will decrease weed and rodent populations, prepare the fields for reforestation, and maintain the functionality of the existing irrigation system.

The average cost is projected at $4,538 per acre for the woody species. The native grasses and sedges are projected at an additional $820 per acre. The costs are comprehensive and include hydrologic studies, implementation plans, irrigation system repairs, and all other field expenses associated with the three-year lifecycle of each restoration phase.

The sequence of restoration phases, over a proposed five-year timeframe, has been designed to accommodate flooding. High water flows, either by natural events or breached levees, will reconnect this emerging riparian forest to its floodplain. Restoration unit plans (specific reforestation designs for each restoration phase) can adapt planting techniques to current or projected hydraulic conditions.

The implementation procedures outlined in this plan are also designed to engage the local community. The active riparian restoration component provides numerous opportunities for participation by landowners, nonprofits, and agency partners in this exciting conservation effort.

SAN JOAQUIN RIVER NATIONAL WILDLIFE REFUGE

PRE-RESTORATION PLAN

I. INTRODUCTION

A. The Study Area

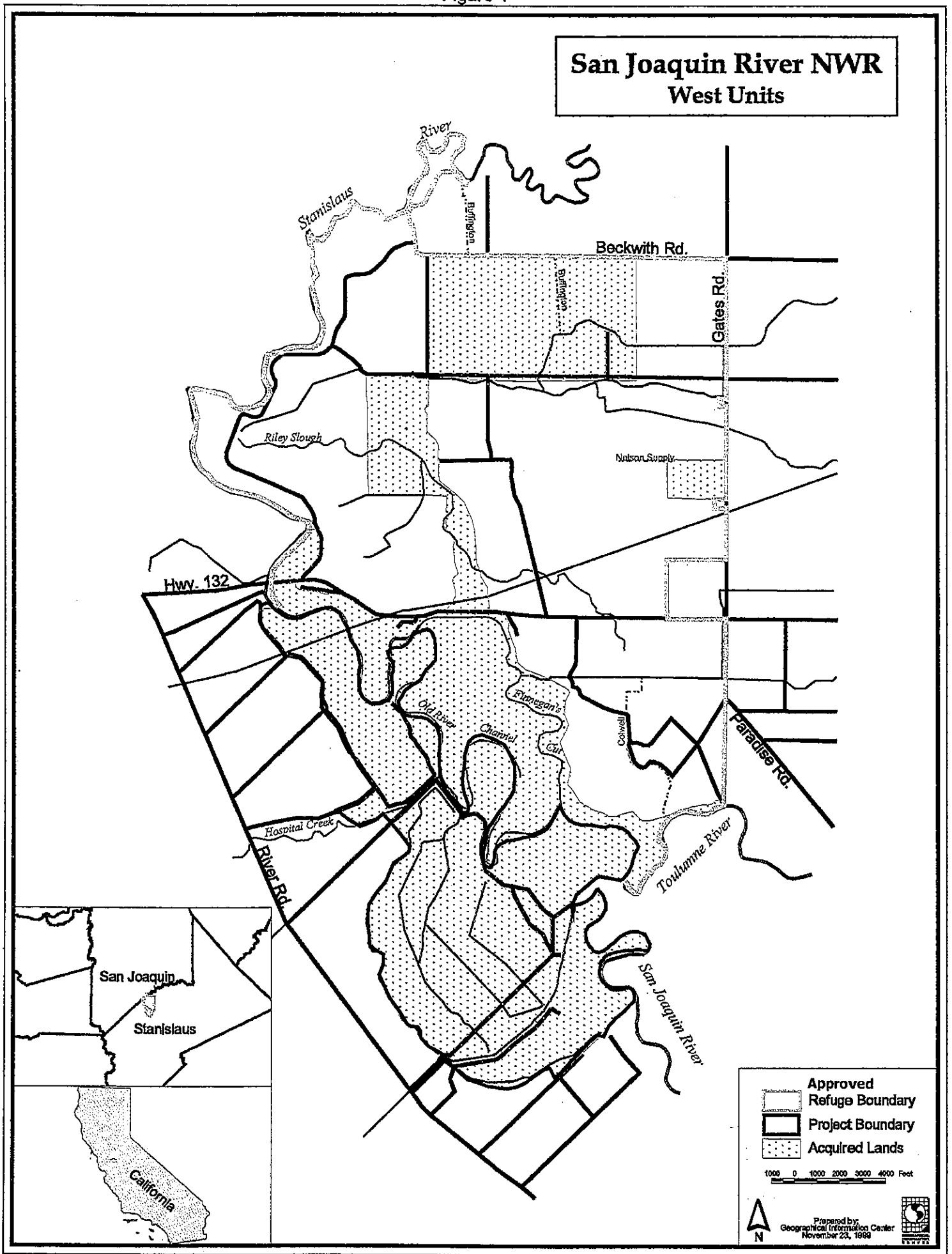
San Joaquin River National Wildlife Refuge (Refuge) located in Stanislaus County, California was initially created in 1987 to provide foraging and roosting habitat for the threatened Aleutian Canada goose on the pastures and fields north of Highway 132 (Figure 1). In 1987, the US Fish and Wildlife Service (USFWS) purchased Christman Island and Gardners Cove (south of Highway 132) to protect some of the last riparian woodland on this reach of the river. In 1999, the USFWS with the Natural Resources Conservation Service (NRCS) purchased 3166 acres of flood-prone farmland located on the west bank of the San Joaquin River. This area is referred to as the "West Unit" and consists of three properties, the Hegemann, Vierra, and Lara properties. After the adjoining levees failed in 1983 and 1997, the previous owners decided to sell. One of the principal reasons for the purchase of the West Unit was to provide a demonstration of non-structural flood relief (US Fish & Wildlife Service 1998 and Chouinard et al 1999). Plans for the West Unit (Non-Structural Flood Protection Demonstration Project, 1997) call for the cutting, or removal, of the levees in a strategic manner to allow flood waters from the river to spread over its former floodplain and relieve pressure on other local levees and communities during times of high flows. Riparian habitats – forests, grasslands, and wetlands - will be restored on the entire acreage as funding becomes available.

B. Purpose of this Report

This report describes how both floodplain function and processes can be restored to the West Unit of the Refuge – between River Mile 77L and 87L. This preliminary plan describes the actions that will restore the recently purchased (1999) West Unit, and the rationale for these actions with estimated implementation timelines and projected budget needs. This report is a planning document that provides the basis of information to conveniently develop funding proposals for the restoration. In the future, after funding is secured for the restoration, an implementation unit plan should be developed for each field for each year that describes such aspects as row and plant spacing, weed control, planting schedule, and other maintenance issues. The implementation unit plan will develop a more refined definition of species composition in each of the plant communities and their planting pattern within each field.

An additional purpose of this report is to include in the restoration planning process the participation of the Natural Resources Conservation Service through its Emergency Watershed Program Floodplain Warranty Easement Deeds and concomitant Conservation Plan Draft (available in draft form). On the Lara and Vierra properties the deeds require

Figure 1


San Joaquin River NWR
West Units
Stanislaus River
Buffington
Beckwith Rd.
Gates Rd.
Riley Slough
Nelson Supply
Hwy. 132
Old River
Finnegan's Cut
Channel
Colwell
Paradise Rd.
Hospital Creek
River Rd.
Tuolumne River
San Joaquin River
San Joaquin
Stanislaus
California
Approved Refuge Boundary
Project Boundary
Acquired Lands
1000 0 1000 2000 3000 4000 Feet
N
Prepared by:
Geographical Information Center
November 23, 1999

the establishment of 50% Riparian Wetlands and on the Hagemann property the easement deed requires 50% Seasonal and Permanent Wetlands. In addition, the deeds cover certain land uses such as the number of acres for Aleutian goose feeding plots. The joint Non-Structural Demonstration Flood Control Project also covers the breaching of the project levees. These uses provide important considerations in the restoration-planning project.

C. Project Goal

The project goal is to work within the Non-Structural Flood Protection Demonstration Project to develop a restoration plan that will convert 3166 acres of farmland into riparian forest within a five-year period.

D. Specific Objectives

This report presents a general restoration plan that once implemented should meet the following objectives:

1. Provide habitat for characteristic wildlife species found in California's Central Valley riparian systems.
2. Allow for the establishment of new populations of listed species- Riparian Brush Rabbit, Riparian Woodrat, and Valley Elderberry Longhorn Beetle.
3. Implement riparian restoration in a manner that facilitates fish access and egress during flood events.
4. Provide habitat for nesting and foraging by riparian obligate songbirds: Yellow-billed cuckoo, Blue grosbeak, Yellow warbler, various flycatchers, as well as other neotropical migrant birds, such as the Swainson's hawk.
5. Provide during times of flooding, or during prescribed flow releases from dams on the tributaries, rearing habitat for salmon and steelhead.
6. Provide spring spawning habitat for the Sacramento Splittail.
7. Provide wetland habitats for waterfowl and shorebirds.

II. EXISTING CONDITIONS

A. Land Use History

The land currently part of the West Unit was used for livestock grazing and cultivated agriculture and evidence of agriculture and channel alterations are evident from documents from the early 1900's. For example, Finegan's cut was present on the 1913 quadrangle map, and aerial photographs from 1930 show extensive row-crop fields on the Vierra (Dairy) property with levees in place. Newer, higher levees are more recent, some constructed by the US Army Corps Of Engineers.

All three properties of the West Unit were predominately used for agricultural land uses. The Hagemann property was used for orchard and row crops. In 1926, the West Stanislaus Irrigation District developed a canal system, and the engineer who designed this system also designed the Hagemann Ranch fields and irrigation system. By the 1960's, the higher fields contained apricot orchards, but high water tables and salt accumulation limited farming on the lower fields. The landowner at the time, Ed Hagemann, installed drains under the lowest fields and eventually brought the fields to higher productivity. Eventually, the orchard was removed and until last year, used for

row-crops. From the 1960's to 1997, the Hagemann property flooded only 2 times (1983 and 1997) due to levee breaks. Ed Hagemann would intentionally flood his eastern fields (field numbers 6,7,8,9), with a backing flood from an intentional cut in a levee, before high water arrived. This would equalize the hydrostatic pressure on both sides of the levee, thereby reducing the chances of a break where the current was strongest and avoiding major deposition of sand in his fields. The Vierra property had been a dairy and also supported row crops at least since the 1930s based on an aerial photograph from 1930. The Lara property is currently in alfalfa production. A series of ponds were created along the southwest boundary long ago, for waterfowl hunting. The pond in the southeast edge of the Lara property is surrounded by a relic meadow.

In 1999, the U.S. Fish and Wildlife Service added the Vierra, Hagemann, and Lara properties to the San Joaquin River National Wildlife Refuge.

B. Site Description

1. Farming Infrastructure

A complex network of canals, lift pumps, control structures, and drainage ditches, deliver and drain water from all the fields on the West Unit (Figure 2). All fields are flood irrigated with river water delivered by the canals. Figure 3 identifies the location and acreage of agricultural fields on the West Unit. Table 1 describes the existing vegetation, soil type, proposed plant community, and selected comments on each of these fields.

2. Existing Vegetation

a) Farm fields

Most of the farm fields have not been farmed since the January 1997 flood. The exceptions are the higher fields of the Hagemann property, which were farmed in 1998 (but not 1999); and the Lara property, which is currently (1999) in alfalfa. Today, without farming, vigorous weeds dominate these fields. Six to eight feet tall individuals of prickly lettuce and horseweed dominate all the fields on the West Unit. In slightly more moist areas (due to finer soil texture) white sweet-clover, and sunflower, both also eight feet tall, are abundant and dominant (these are impentratable to a human on foot). On the drier, more elevated fields, as at the south and east side of the Hagemann property, the lettuce and horseweed are just as abundant, but much shorter, about three feet tall, with locally abundant stands of black mustard and patches of annual grasses, including Rip-gut brome (Appendix A contains a complete species list). A map titled "Lara, Hagemann, and Vierra Conceptual Restoration design October 5, 1998" shows Hagemann fields 6, 7, 8, 9 as "current wetlands and riparian habitat". In August 1999, no evidence of this was found. These fields are covered by the same agricultural weeds found over the other farm fields. A few black (valley) willow saplings have managed to survive along the main field drain.

Table 1. Description of Fields on the West Unit, San Joaquin NWR

Field Number	Acreage	Existing Vegetation	Soil Type	Proposed Plant Community	Comments
V1	80	Fallow weeds	150, 151, 160	Mixed Forest	Breached Levee at North End; Powerline Aqueduct Corridor
V2	52	Fallow Weeds	151, 160	Mixed Forest, Seasonal Wetland	MF – 42 ac, Lake – 10 ac.
V3	52	Fallow, weeds	160, 170	Mixed Forest, Seasonal Wetland	MF – 42 ac, Lake – 10 ac. Breached Levee at SE edge.
V4	88	Fallow, weeds	175, 195	Wetland, Buttonbush Scrub	BB – 20 ac, Lake – 68 ac
V5	23	Fallow, weeds	195	Wetland, Buttonbush Scrub	BB – 8 ac, Lake – 15 ac
V6	25	Seasonal wetland	195	Wetland	Lake – 25 ac
V7	114	Fallow, weeds	128, 165, 175	Buttonbush Scrub, Mixed Forest	BB – 40 ac, MF – 74 ac
V8	40	Fallow, weeds, valley willow, cottonwood saplings	151	Mixed Forest	Potential Cuttings Nursery Site
V9	6	Housing			Long term
V10	29	Dairy Barns			
V11	7	Marsh, tules	116		
V12	7	Drain, weeds			
V13	37	Fallow, weeds	159	Mixed Forest	Riverside of Levee
H1	26	Fallow, weeds, grazed	175	Buttonbush/Mixed forest, wetland	BB – 13 ac, Lake – 13 ac
H2A	42	Fallow, weeds	175	Mixed Forest	
H2B	13	Fallow weeds	175	Mixed Forest	
H3	31	Fallow, weeds	200	Mixed Forest	
H4	37	Fallow, weeds	200	Mixed Forest	
H5	21	Barn	157	Valley Oak forest	
H6A	65	Fallow, weeds	151, 170	Mixed forest	Riverside of Levee
H6B	65	Fallow, weeds	157,170	Mixed Forest	Riverside of Levee
H7	10	Fallow, weeds	151	Mixed Forest	Riverside of levee
H8	83	Fallow, weeds	151	Mixed Forest	Riverside of levee
H9	100	Fallow, weeds	151, 160	Mixed Forest	Riverside of levee
H10	70	Willow scrub	153, 180	Willow Scrub	Riverside of Levee; Borrow Area
H11	70	Fallow, weeds, lake shore	155, 165	Buttonbush scrub	High density voles
H12	30	Fallow, weeds, seasonal wetland	101, 155	Buttonbush Scrub/Lake	BB – 25 ac, Lake – 5 ac
H14	60	Lake	195	Lake	

Table 1. Description of Fields on the West Unit, San Joaquin NWR (continued)

Field Number	Acreage	Existing Vegetation	Soil Type	Proposed Plant Community	Comments
H15	134	Lake, Fallow, weeds	175, 195	Lake	
H17	122	Fallow, weeds	175, 195	Lake/Buttonbush Scrub	BB – 90 ac, Lake – 32 ac
H18	160	Fallow, weeds	157, 175	Lake/Buttonbush Scrub/ Mixed Forest	BB – 40 ac, MF – 100 ac; Food Plot), Lake – 20 ac
H19	103	Lake	195	Lake	
H20	68	Fallow, weeds	165	Mixed Forest	
H21	130	Fallow, weeds	157, 175	Buttonbush/Mixed Forest	BB – 30 ac, MF – 100 ac
H22	89	Fallow, weeds	157, 200	Mixed Forest	
H23	86	Fallow, weeds	157, 200	Mixed Forest	
H24	30	Fallow, weeds	157, 175	Valley Oak Forest	
H25	45	Alfalfa	175, 200	Valley Oak Forest	
H26	76	Fallow, weeds	157, 200	Valley Oak Forest	
L1	24	Alfalfa	195	Lake	
L2	30	Ponds, creeping rye meadow	195	Creeping rye Meadow	Lake (30 ac), Hunting ponds and seepage area
L3	44	Alfalfa	165	Mixed forest	
L4	18	Alfalfa	157	Buttonbush Scrub	
L5	10	Alfalfa	157	Buttonbush Scrub	
L6	42	Alfalfa	165	Mixed Forest	
L7	128	Alfalfa	157, 165	Valley Oak Forest	
L8	32	Alfalfa	157, 165	Valley Oak Forest	
L9	8	Alfalfa	165	Valley Oak Forest	
L10	3	Meadow	151	Meadow	
L11	14	Sheep feed lot/meadow	157	Potential riparian brush rabbit refuge, Valley Oak forest	Meadow – 7 ac, Valley oak – 7 ac

Figure 2

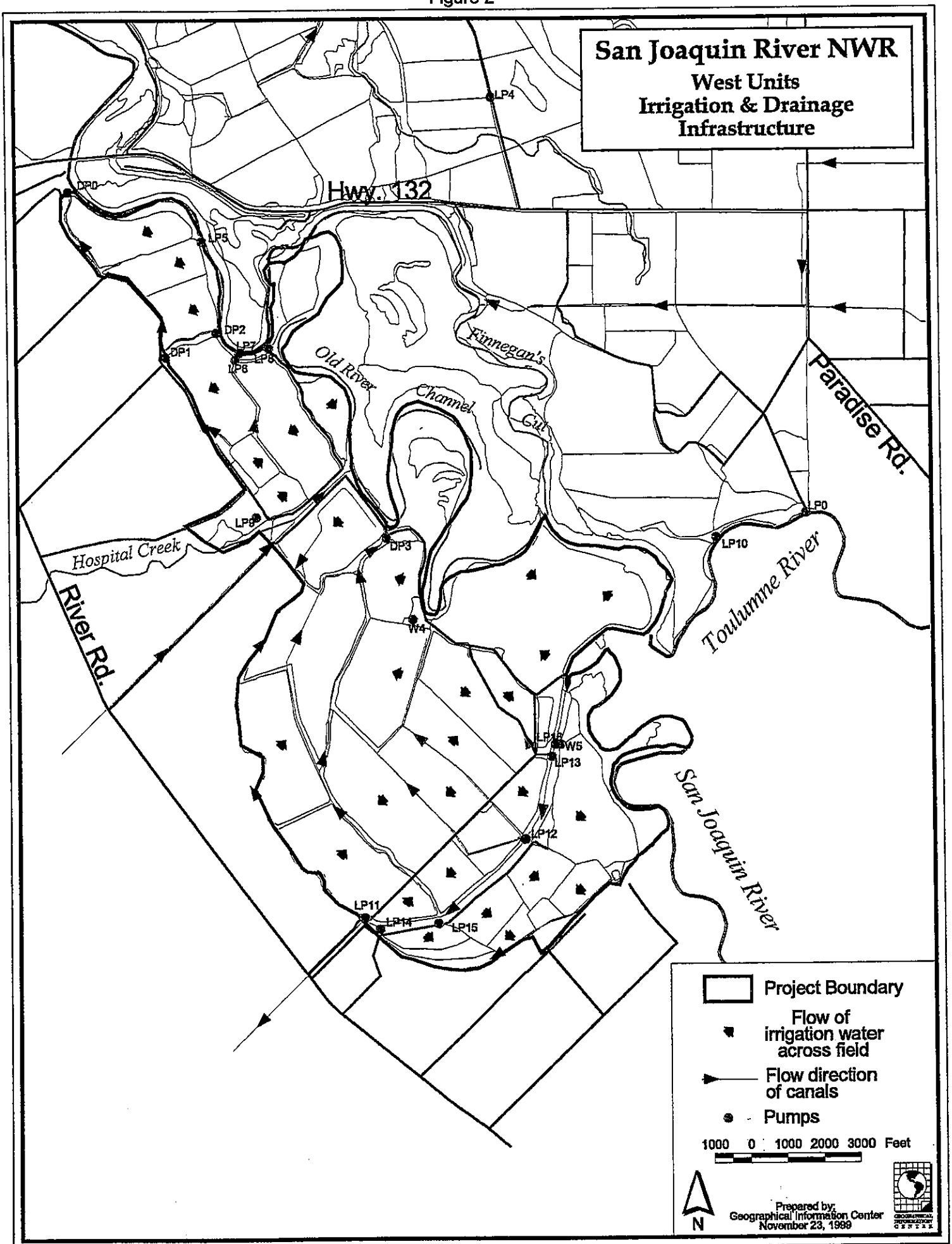
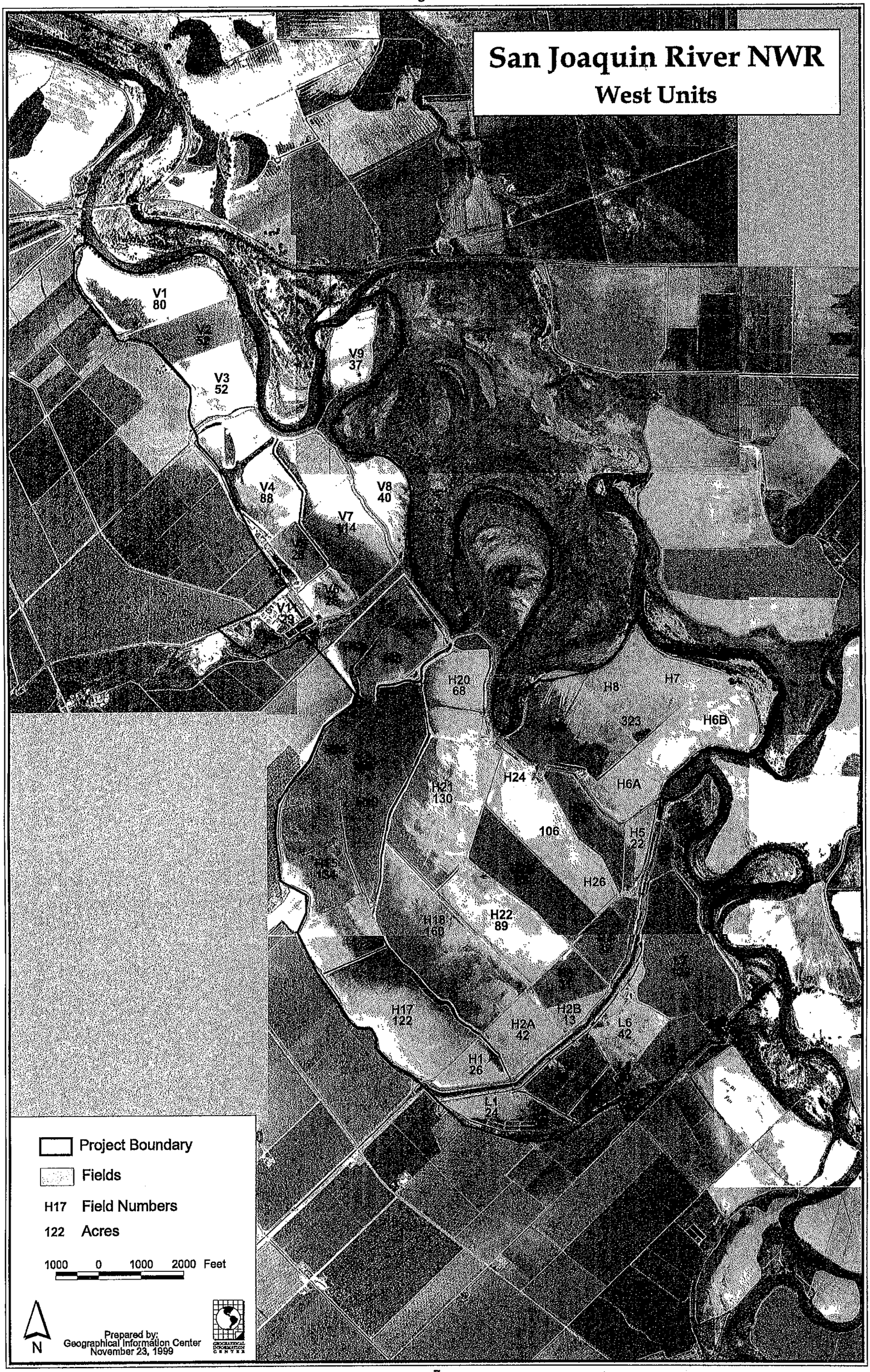

San Joaquin River NWR
West Units
Irrigation & Drainage
Infrastructure
Hwy. 132
LP4
DP0
LP5
DP2
DP1
LP7
LP8
LP6
Old River
Channel
Finnegan's
Cut
Paradise Rd.
LP0
LP10
LP9
DP3
Hospital Creek
River Rd.
Toulumne River
W4
W5
LP13
LP12
San Joaquin River
LP11
LP14
LP15
Project Boundary
Flow of irrigation water across field
Flow direction of canals
Pumps
1000 0 1000 2000 3000 Feet
N
Prepared by:
Geographical Information Center
November 23, 1999

Figure 3


San Joaquin River NWR
West Units
V1
80
V2
33
V3
52
V4
88
V5
V7
114
V8
40
V9
37
V11
23
H20
68
H8
H7
323
H6B
H24
H6A
H21
130
106
H5
22
H16
134
H26
H18
160
H22
89
H17
122
H2B
13
H2A
42
L6
42
H1
26
L1
24
Project Boundary
Fields
H17 Field Numbers
122 Acres
1000 0 1000 2000 Feet
N
Prepared by:
Geographical Information Center
November 23, 1999

One of the most significant attributes of the West Unit is the *relative lack* of such noxious weedy species as starthistle and Johnson grass. This is probably due to the aggressive weed control practiced by growers in this area. There is no Starthistle on any of the properties (the small stand at the West Stanislaus Road gate was sprayed this spring before it could set seed). Johnson grass is absent from the Hagemann property, but a several acre stand can be found east of the Dairy, north of Hospital Creek. Wide-leaved pepperweed can be found scattered throughout the Refuge, but it only forms dense mats and thickets on the levee tops and sides where mechanical disturbance has been frequent.

The flooding patterns of 1997 and 1998 allowed seedlings and saplings to develop on several of the former agricultural fields. However, by summer of 1999 most of these are dead, due to severe competition from weeds and the unnatural flow regime after the floods, which did not train the roots to grow downward into the water table. (See Hydrology section, below). Only one field – east of the levee, east of the dairy – supports sapling valley willows and a few cottonwoods in significant numbers. This field contains a productive silt loam and is an ideal site for a cottonwood-willow nursery (Figure 4).

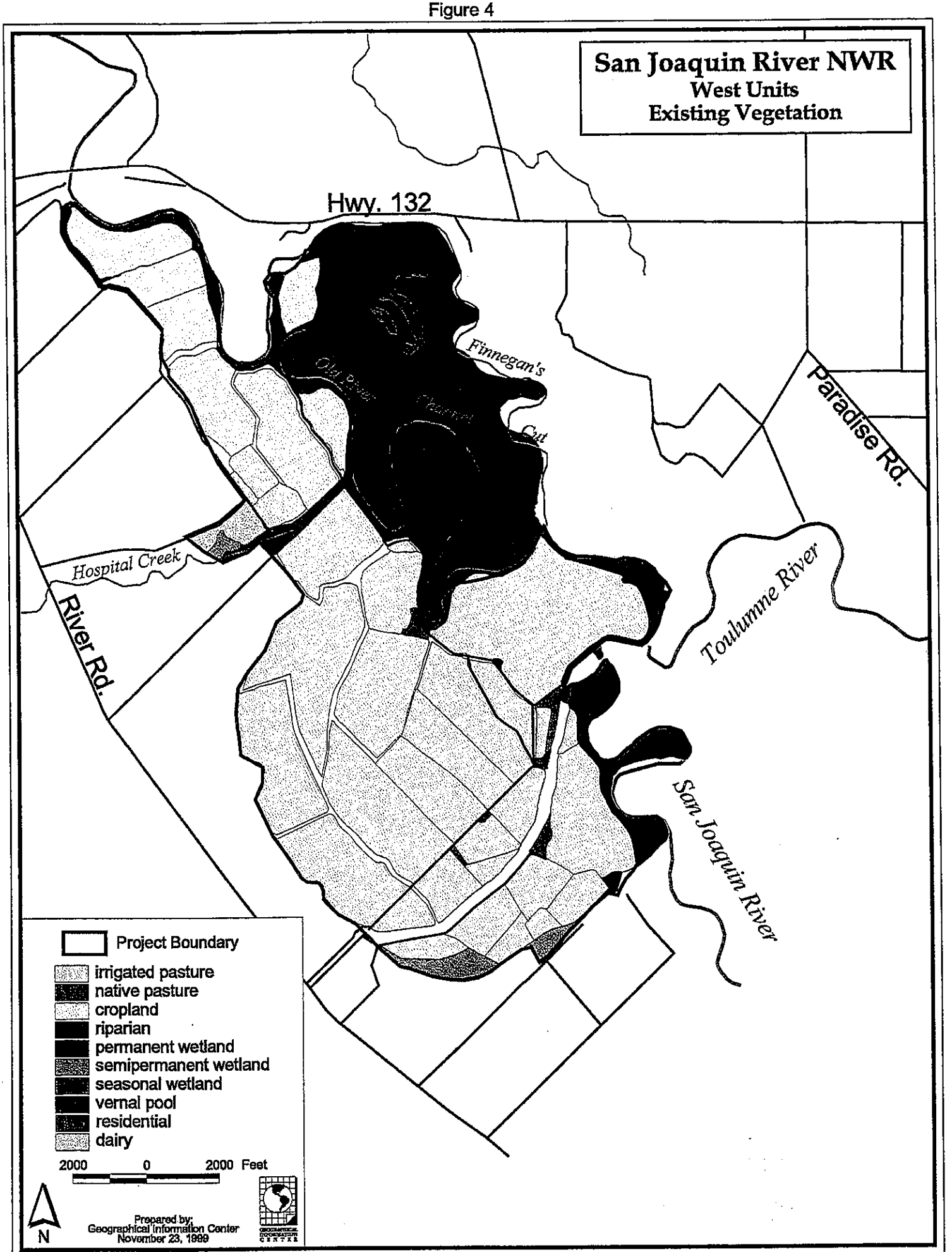
b) Riparian communities

Riparian communities occur only along the river, east of the levees, and east of the farm fields. They are dominated by valley (or black) willow, the most common tree (Sawyer and Keeler-Wolf's black willow series). Sandbar willow, box-elder, buttonbush, and Oregon ash are frequent; California rose is occasional; Fremont cottonwood is present as widely spaced individuals or small groups; valley oak occurs as scattered individuals throughout the non-farmed refuge lands, and a few closed canopy groves occur on Christman Island (Sawyer and Keeler-Wolf's Valley Oak Series). Sapling valley oaks (5-20 feet tall) are common. Elderberry is very rare. The understory of the riparian area is dominated by natives, unlike most other riparian areas in the state. California blackberry, mugwort, goldenrod, basket sedge, creeping rye grasses are common, and in most places have excluded the non-natives. This year the yellow-flowered evening primrose is very abundant, forming hedges 5-8 feet tall of bright yellow flowers in the morning sun – these will be gone next year, as this plant is a biennial.

Several species that were not observed, but which are common at many other riparian woodlands elsewhere in the Central Valley include California sycamore, wild grape, poison oak, and pipevine. Elderberry is extremely rare with one shrub on the Lara property, one shrub at the bridge on Grayson road, and several individuals growing on the shoulder of Highway 132. Arroyo willow is found only at the relict meadow as one large shrub and there are four saplings east of the Dairy.

The absence of noxious weeds in the riparian zone is also remarkable. Himalaya berry is apparently absent, unlike most other riparian areas in the Central Valley. Also, there is currently no salt-cedar or tree of heaven. The few patches of arundo are being treated

Figure 4


San Joaquin River NWR
West Units
Existing Vegetation
Hwy. 132
Finnegan's Cut
Old River
Paradise Rd.
Hospital Creek
River Rd.
Tuolumne River
San Joaquin River
Project Boundary
irrigated pasture
native pasture
cropland
riparian
permanent wetland
semipermanent wetland
seasonal wetland
vernal pool
residential
dairy
2000 0 2000 Feet
N
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Geographical Information Center
November 23, 1999

with herbicides by Refuge staff. Black walnut is currently poised to invade the Refuge. Saplings are growing on Hospital Creek as it enters the Refuge.

Wildfire has been a component in defining the structure of the riparian woodland on Christman Island. Ed Hagemann describes a crown-fire about ten years ago that resulted in a "moon-scape". Fire scars exist on all the valley oak trees. These oaks generally have multiple trunks, indicating their origin as crown-sprouts, arising after fires. Frequent fire may also explain the abundance of understory species, which would benefit from occasional removal of accumulated dry-matter. However, such fires destroy the habitat of several species of concern (shrub- and tree-nesting birds and the brush rabbit) when it consumes the woodland.

c) Wetland communities

(1) Lakes and Permanent Wetlands

Lower White Lake formed (367 acres) in 1999 as a result of changed drain pump management and from the natural high water table and irrigation run off from neighboring agriculture fields. Bulrushes and cattails dominated the lakebeds. Waterfowl and shore birds utilized the lakes in the summer and fall of 1999.

(2) Seasonal Wetlands.

Seasonal wetlands formed in the field east of the dairy. Unintentional flooding due to high flows of agricultural drain water from Hospital Creek in early July caused this field to grow watergrass.

(3) Relict Meadow.

Less than one acre exists along the extreme south boundary of the West Unit (Lara property) supporting a unique community of plants that require a high water table (Sawyer and Keeler-Wolf's Creeping rye series) see Appendix A. This community is extremely rare today in the San Joaquin Valley due to the lower water tables compared to pre-European times.

C. Hydrology

The entire Refuge is within the historic and current floodplain of the San Joaquin River. All major tributaries have two or more dams and are highly regulated for flood control and to provide irrigation water for the most productive farming region in North America. Without levees, most of the Refuge would flood during most years (see Stage-Discharge curve developed by NRCS, (Hollett 1997)). In pre-European times this portion of the San Joaquin was a highly meandering, depositional river, approaching sea level, as it enters the Delta a few miles to the north. The active channel today has been in exactly the same place for nearly 100 years based on the 1915 quadrangle map of the area. Hence, there has been no channel movement or meandering, a very important river process necessary for forest regeneration. Based on the soil types, the property probably remained under water well into July or August during average and high rainfall years, before the construction of dams. Additionally, based upon soil type, Upper and Lower

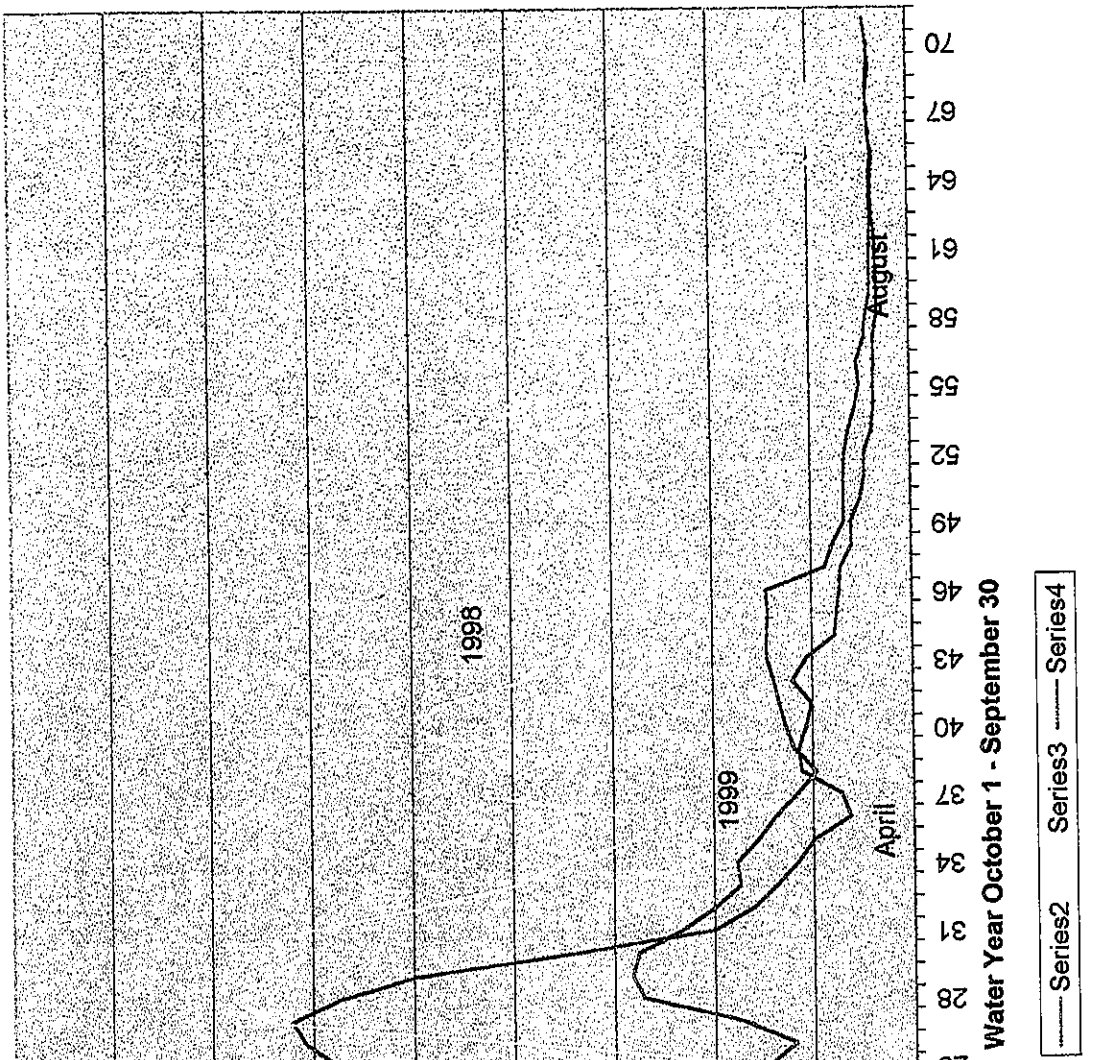
White Lakes were probably one much larger lake in prehistoric times. Today, the White Lakes are absent only because their beds have been tiled and ditched in order to pump the water table down so that farming is possible. Without these drain pumps continuously working, Lower White Lake will reform, as was demonstrated in 1999.

Figure 5 shows the hydrographs for water years 1997, 1998, and 1999. Flows at Vernalis (2-6 miles downstream of the West Unit) on this reach of the San Joaquin River is regulated by dams on all the major tributaries (such as the Tuolumne and Merced rivers) and on the San Joaquin River itself at Friant dam near Fresno. Thus these hydrographs represent a highly regulated system. The hydrograph for 1997 shows the high flows in January associated with the major flood that started on January 1, 1997. Rainfall later in the spring of 1997 was less than average, allowing the flows to drop back to the long-term average (2000-3000 cfs) by April. The hydrograph for 1998 reflects the near record rainfalls of this "El Nino" year. Interestingly, flows remained above 15,000 cfs until early August and remained nearly double the average for the remainder of the summer. The hydrograph for 1999 reflects a more "typical" shape as a result of rainfall patterns and amounts that were closer to long-term averages.

Because the flows of the San Joaquin are so severely regulated, natural regeneration of the riparian forest will take a very long time. The flood of January 1997 created the conditions for limited reproduction of valley willow and Fremont cottonwood on some of the fields on the Refuge (Refer to Hydrograph Figure 5). The very wet El Nino year of 1998 followed and supported these seedlings with an unusually high water table through the entire summer, allowing them to grow into saplings 5-10 feet tall. However the flows in the spring and summer of 1999 returned to the more typical hydrograph, namely very low relative to pre-dam flows. This resulted in a lower, and more typical, water table under these saplings. Most of the valley willows in the agriculture fields were dead by August due to drought stress – they were unable to grow their root systems to the water table, which in 1999 was much lower that in 1997 or 1998. There are a few small exceptions such as areas east of the Dairy and along the Hetch-Hetchy aqueduct. Perhaps 80 to 90 percent of the Fremont cottonwoods also succumbed by late summer 1999 due to having their stems girdled (bark removed) by voles and rabbits. Under a more natural flow regime the vole and rabbit populations would have been decreased by the winter and spring floods (they would have drowned). A survey of rodents on the refuge carried out for the Biological Inventory (Chouinard et al, 1999) found much higher relative abundances of mice and voles in fallow agricultural fields as compared to native vegetation.

The base flow in the river is maintained by drain water from upstream agriculture. Currently, this flow is sufficient to maintain a relatively high water table under the entire property. The NRCS has provided a Stage-Discharge analysis for the Refuge based upon historical data from the gauge at Vernalis (near Highway132 crossing). Based upon statistical probabilities, the entire refuge will flood for at least seven days every two years (Hollett 1997). (See also soil pit evaluation for depth to water table). Ed Hagemann reports that water quality of the irrigation water from the river varies through the year,

Figure 5


Hydrographs at Vernalis, San Joaquin River. Series 2= 1997; Series 3= 1998; Series 4= 1999
Flow in cfs
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
1997
1998
1999
January
April
August
1
4
7
10
13
16
19
22
25
28
31
34
37
40
43
46
49
52
55
58
61
64
67
70
Water Year October 1 - September 30
Series2
Series3
Series4

averaging about 600 ppm dissolved solids, but increasing in the late summer to as high as 1200 ppm.

D. Topography

The property is bounded on the east and north by the active channel of the San Joaquin River (Figure 6). Most of the south and west property boundary is a natural topographic break of 10-15 feet. That is, the Refuge is 10-15 feet lower than most of the neighboring properties. Refuge staff would like to install monitoring wells on the neighbor's property to determine any impacts of raising the level of water in the drain system to allow White Lake to form. Elevation of the farm fields ranges from about 25 feet above sea level at the north edge of the Refuge, to 40 feet on the Hagemann unit.

E. Soils

The Natural Resources Conservation Service (NRCS) mapped the soils in 1992. See Appendix C for this list and the detailed results of the backhoe excavations (Figure 7). Fluvial processes form most of the soil types on the Refuge property (Columbia, Merritt, DosPalos-Bolfar). The exception is the Clear Lake clay, which is formed in basins under standing water. The Clear Lake Clay delineates the bed of the pre-European Upper and Lower White lakes. It is a hard, brittle clay with very little water-holding capacity and would not support woody vegetation. Clear Lake Clay would best be restored to seasonal or permanent wetlands. All the remaining soil types are Class I agricultural soils that will support a variety of woody riparian plants.

Backhoe pits were excavated to determine the suitability of the different soils and fields for restoration and to help determine which plant community to install. Soil texture and its stratification, and depth to water table are the most important characteristics of a soil profile that determine species composition and pattern. In addition, the presence of mottles – oxidized iron (orange) and oxidized manganese (black) – indicates where the seasonal water table lies. Since the pits were excavated at the end of the dry season, we can assume that the water table is at its maximum depth. The layers with mottles indicate where the water table is during the winter and spring. Our goal was to excavate to the water table, then measure the depth below the surface of each textural group (sand, silt, or clay).

Stratification of the profile, while present, was a gradual blending between layers and should not impede root growth to the water table. However, depth to water table will be a factor in determining the species mix on fields near the lakes and wetlands. For example, on soil number 128 in the field east of the dairy, mottles at 2 feet indicate the spring water table. Valley willow and buttonbush would best tolerate and grow under this condition, while elderberry and oak may find this site too wet and succumb to root diseases. On Hagemann, field 25, we found a white calcareous hardpan at 7 feet. This will preclude the survival of willows and cottonwoods because they will not be able to reach the water table. However, valley oak, elderberry, coyote brush, and native grasses should do well here. The areal extent of this hardpan will need to be determined with more pits before an accurate planting design can be generated in this area.

Figure 6

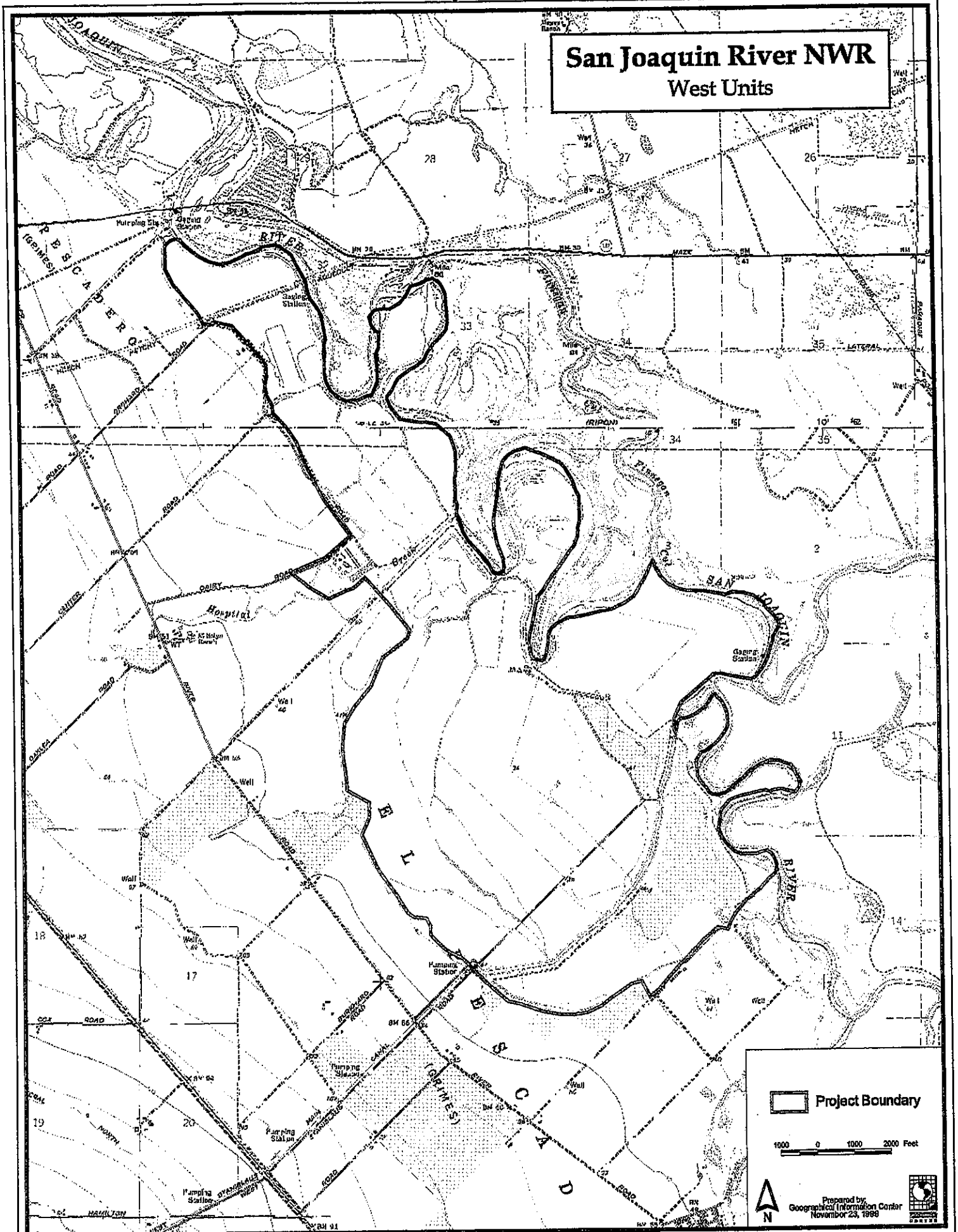
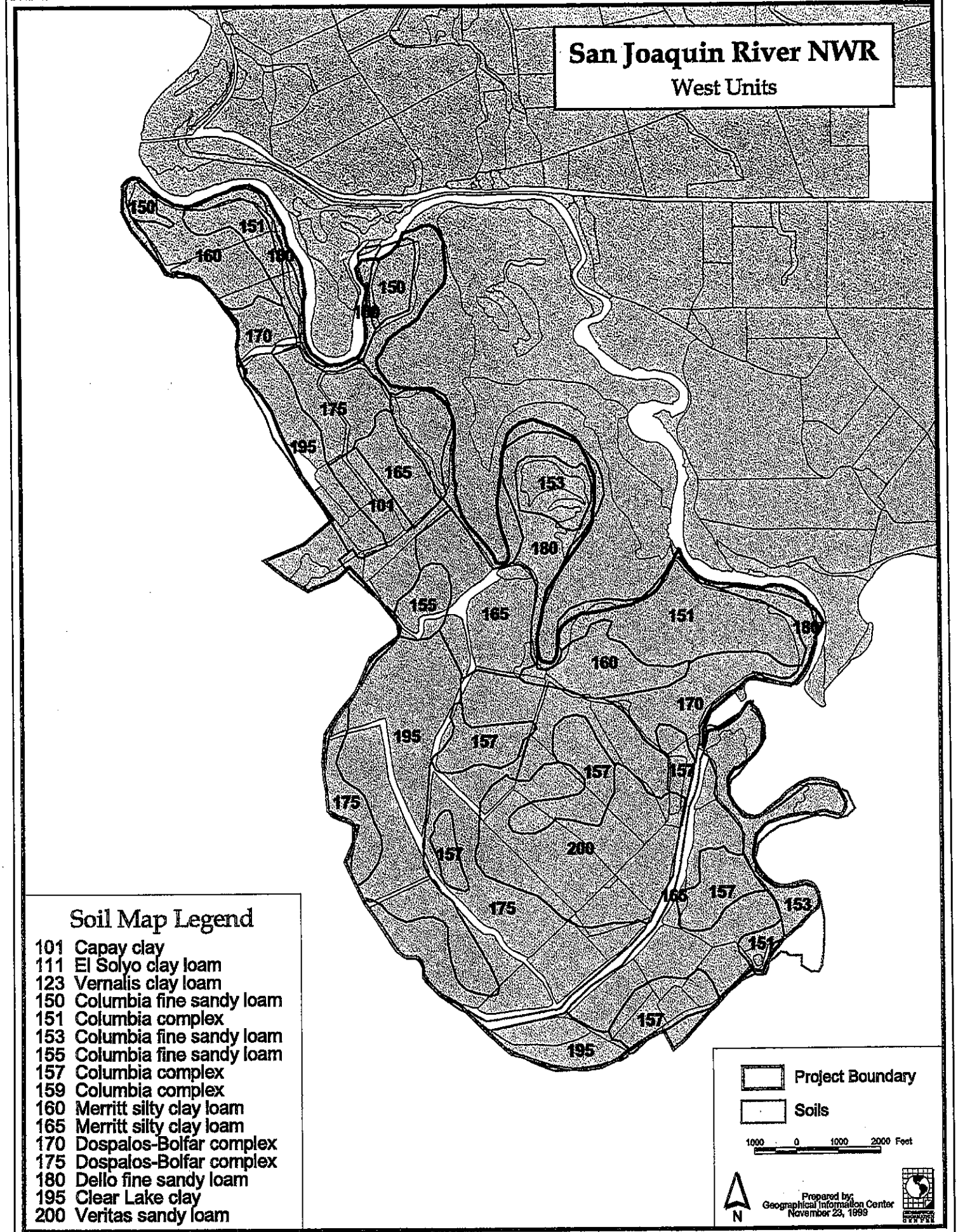

San Joaquin River NWR
West Units
Project Boundary
1000 0 1000 2000 Feet
N
Prepared by:
Geographical Information Center
November 23, 1999

Figure 7


San Joaquin River NWR
West Units
150
151
160
180
150
170
175
195
165
153
101
180
155
165
151
160
170
195
157
157
157
175
157
200
175
157
153
151
157
195
Soil Map Legend
101 Capay clay
111 El Solyo clay loam
123 Vernalis clay loam
150 Columbia fine sandy loam
151 Columbia complex
153 Columbia fine sandy loam
155 Columbia fine sandy loam
157 Columbia complex
159 Columbia complex
160 Merritt silty clay loam
165 Merritt silty clay loam
170 Dospalos-Bolfar complex
175 Dospalos-Bolfar complex
180 Dello fine sandy loam
195 Clear Lake clay
200 Veritas sandy loam
Project Boundary
Soils
1000 0 1000 2000 Feet
N
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November 23, 1999

III. PROPOSED PLANT COMMUNITIES

A. Reference Sites

One of the fundamental components of a restoration plan is the identification of reference sites to use as guides for developing the list of species to be installed and their pattern across the restoration site. Reference sites on the Refuge are few to non-existent, due to the long history of human modifications of the flood patterns and flow regulation. The historical photographs from 1930 show a riparian forest dominated by valley oak in a density that approaches the definition of a forest (>80 percent cover). Today, Christman Island and Gardners Cove are dominated by valley willow and valley oak. Both are species which possess highly developed abilities to tolerate fire and drought conditions, compared to other riparian species which are very much reduced in abundance or have been completely lost (e.g., arroyo willow). Consequently, many of the recommendations listed below are derived from inferences based upon the presence of species on the refuge, and not upon existing examples of cover types (or communities) as found in Sawyer and Keeler-Wolf (1995) or Holland (1986). For example, nowhere on Christman Island or Gardners Cove are there examples of mixed riparian forest; only small patches (< one acre) of valley willow-buttonbush scrub exist along Hospital Creek as it flows north along a former channel of the river. Small groves (< 10 acres) of valley oak forest (without elderberry) can be found (as at the Heron rookery). However, these groves support a very rich understory composed exclusively of natives. Arroyo willow can be found at only two locations: one at the relict meadow on the Lara property, where it is growing on the Columbia soil type, the same soil type where it thrives along the Sacramento River; and as four, two-year old saplings east of the dairy.

Therefore, the following recommended plant community types and species lists are based upon both what remains along the San Joaquin River, and upon inferences based upon soil types (deep, Class I agricultural soils) and conditions which support more diverse communities elsewhere in the Central Valley. The recommended plant communities follow the nomenclature of Holland (1986) because it is a much more refined description of vegetation types compared to Sawyer and Keeler-Wolf (1995).

B. Proposed Riparian Tree, Shrub, and Understory Communities.

1. Buttonbush-Valley Willow Scrub – (Holland Type 63119)

This community should be planted at the lowest elevations, at the edge of the White Lakes. This community is composed of species that can tolerate and prosper with a high water table (2-4 feet), or completely saturated soils during the growing season. The herbaceous "relict meadow" species (fleabane, hedge-nettle, and loosestrife) should be planted as plugs in this community type to allow them access to the lake and wetlands for seed dispersal. Suggestion: By temporarily lowering the level of the lake for a few years while the buttonbush and valley willow establish, then raise the lake level to flood the planting, a swamp (woody wetland) or ox-bow lake community can be created.

Twenty- five years from now, this planting will be a fairly dense woodland of buttonbush and valley willow with ash and cottonwood scattered among them; the herbaceous plants will be throughout the woodland, primarily in light-gaps between the trees.

An example of this community type can be seen at the Cosumnes River Preserve along the Willow Slough Trail. This type supported a black-crowned night heron rookery at Creighton Ranch near Corcoran in 1979-80.

The areal extent of the lake and wetlands must be determined before planting can commence. At this writing, it is unclear as to precisely where the edge of these wetlands will be. Our best estimates are reflected in Figure 8.

Percentages of each species in the planting mix (palette) will be determined during the unit planning process (please see Appendix B: Species List). A hypothetical mix of species from each proposed community is shown in Table 2.

2. Mixed Riparian Forest (Holland Type 64120)

This community should be planted at the mid-elevations with a water table at 4-10 feet depth. The planting palette for mixed riparian forest will contain the largest number of species of any of the restoration community types. Nearly all the plant species on the list could be grown on these sites. Valley oak will be a significant component of the planting palette (20%).

Valley oak grows slowly compared to cottonwood and willows, however it will eventually – in 25-50 years – become the dominant tree, causing the refuge to appear similar to the 1930 photographs. Communities of this type are uncommon except at several locations on the Sacramento River.

3. Valley Oak-Elderberry Forest (Holland Type 61430)

This community should be planted on the highest elevations of the Refuge at sites with the greatest depth to water table. This will be the community that will grow on the proposed, riparian brush rabbit refuges that is above the maximum flood line. The planting palette should include coyote brush, as it is the only evergreen plant in the riparian zone, thereby providing cover for the rabbits and other wildlife during the winter. Reviewing the 1930s photographs, it appears that valley oak was the dominant tree on the Refuge land before conversion to agriculture.

In 25- 50 years this will be a closed canopy valley oak forest similar to Caswell State Park. However, the understory will be more diverse with blackberry, basket sedge, rose, creeping rye grass. In the light gaps coyote brush and elderberry will be present.

Figure 8

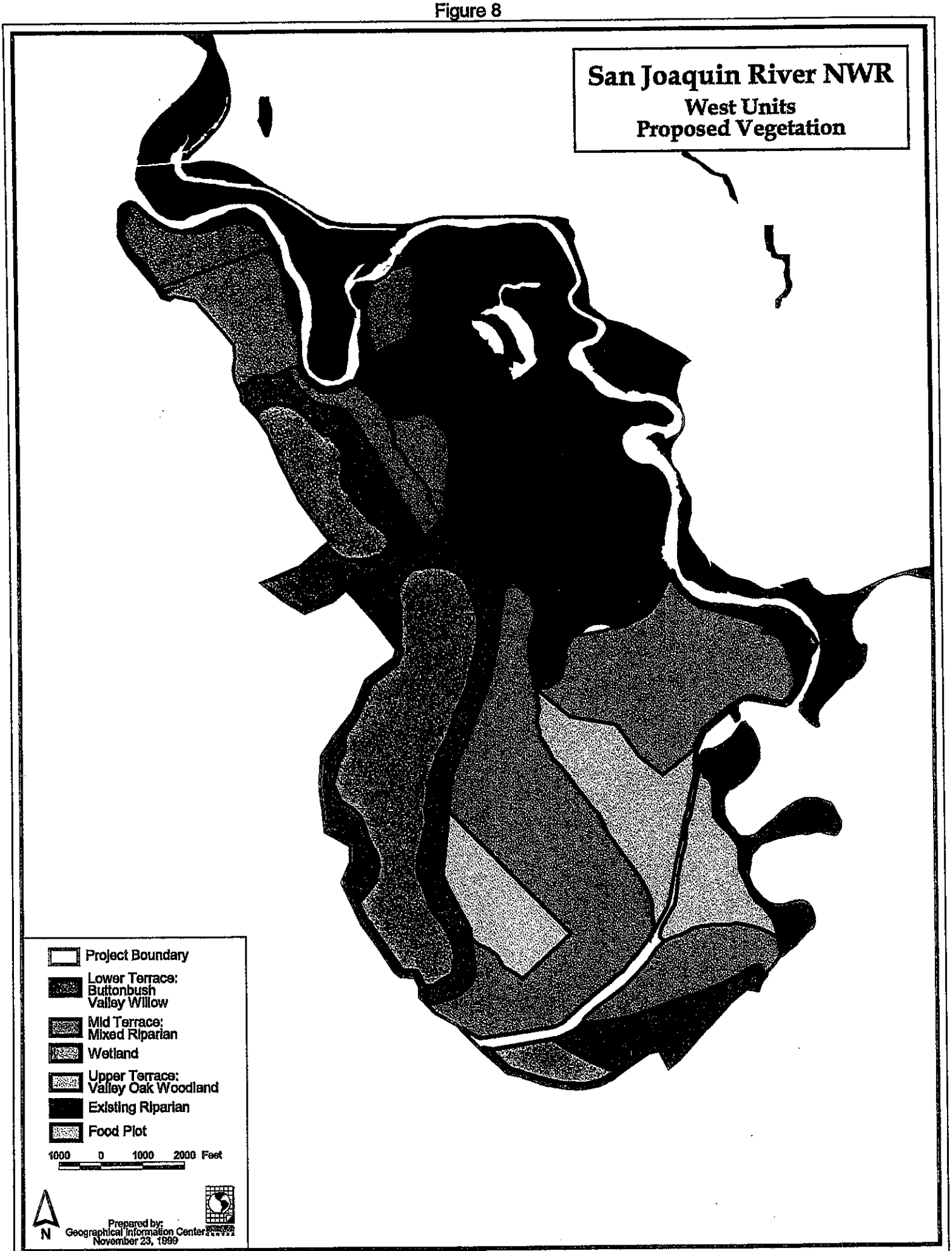

San Joaquin River NWR
West Units
Proposed Vegetation
Project Boundary
Lower Terrace: Buttonbush Valley Willow
Mid Terrace: Mixed Riparian
Wetland
Upper Terrace: Valley Oak Woodland
Existing Riparian
Food Plot
1000 0 1000 2000 Feet
N
Prepared by:
Geographical Information Center
November 23, 1999

Table 2. Hypothetical Mixes of Species for Proposed Communities for the West Unit of the San Joaquin NWR

Community	Buttonbush-Valley Willow Scrub	Mixed Riparian Forest	Valley oak-Elderberry Forest	Moist-soil herbs from relict meadow sites (Creeping rye and Alkali meadow)	Permanent Wetland in and around Lower White Lake	Levees
Holland Type	63119	64120	61430	42147 45300		
Species Mix	**Woody species:** Valley Willow 40% Buttonbush 40% Oregon Ash 10% Fremont Cottonwood 10% **Herbaceous species:** Basket-sedge 20% Creeping Ryegrass 20% Marsh Baccharis 20% Indian Hemp 20% Creeping Rush 20% Also may include: Fleabane Loosestrife Hedge-nettle	**Woody Species:** Valley Willow 5% Oregon Ash 5% Fremont Cottonwood 5% Box-elder 5% Valley Oak 20% Elderberry 20% Rose 5% California Blackberry 5% Sandbar Willow 5% Mulefat 5% Arroyo Willow 20% **Herbaceous species:** Basket-sedge 50% Creeping Ryegrass 50%	**Woody species:** Valley Oak 20% Elderberry 20% Oregon Ash 5% Rose 5% California Blackberry 10% Sandbar Willow 5% Mulefat 5% Arroyo Willow 10% Coyote Brush 20% **Herbaceous species:** Basket-sedge 50% Creeping Ryegrass 50%			**Woody species:** Rose 20% California Blackberry 20% Coyote Brush 20% Valley Oak 20% Elderberry 20% **Herbaceous species:** Basket Sedge 50% Creeping Ryegrass 50%

4. Moist-Soil Herbs from Relict Meadow Sites (Holland Types: Creeping Rye 42147 and Alkali Meadow 45300)

Plants of the relict meadow site depend upon a high water table to survive and persist. At this early stage of planning, it is unknown where similar areas will develop as White Lake is restored. Therefore, we suggest that these species be planted among the Buttonbush-Willow Community, or planted on the levees that run through White Lake so they will disperse their seed into the lake water and be transported to their "correct" growing location.

5. Permanent Wetland in and around Lower White Lake

Moist soil plants, such as swamp timothy, smartweed, water-grass, will be restored through management of the water level in the lake.

6. Levees

Levees are the highest terrain and support the most vigorous stands of the noxious pepperweed. The levees could be planted with a mix of shrubs with the goal of crowding out the pepperweed. A good reference site is on the east slope of the levee east of the dairy.

IV. RESTORATION PLANNING AND PROCESS

A. Passive versus Active Restoration

Passive restoration strategy means minimum input to restore the forest. As currently practiced this method involves: a) site preparation that removes all weed mulch and crop residue through disking, burning, and/or prolonged flooding; b) flooding the field in early spring. Management of flooding on the field attempts to mimic the recession limb of the annual hydrograph such that the soil surface is exposed by slowly drawing down the water level at the time willow and cottonwood seeds are flying in April and May. Ideally, seedlings would establish and grow to be 3-5 feet tall saplings by the end of year one.

Unfortunately, non-native agricultural weeds- already in the soil or arriving with the irrigation water from the canal - also germinate and rapidly out-grow the tree seedlings, slowing their growth and eventually killing them through shading effects. This method has never been successful in the Central Valley for large-scale restoration. The logistics of weed control with Passive restoration would be complex because a tractor with spray-rig could not access the field until the soil dried sufficiently, allowing the weeds an advantage of early growth. In addition only valley willow and a few cottonwood would likely seed-in, creating a forest of low species diversity that would have limited wildlife value compared to a more diverse stand composed of several species of trees and shrubs. (See Draft Riparian Bird Conservation Plan for examples of bird diversity related to plant species diversity).

Active Restoration is a strategy where modern farming techniques are used to establish the forest, including intensive site preparation, on-going weed control using herbicides as necessary, irrigation through the growing season for up to three years, planting of several

month old saplings from nursery grown container stock. Advantages of this method are: a) demonstrated success of over 80 percent survival after three years in the Sacramento Valley, and b) the methods used are essentially the same as those used to establish commercial orchards, allowing for the opportunity of contracting with local farmers to carry out the implementation, a great outreach benefit.

Sacramento River Partners recommend the Active Restoration approach for restoring the riparian communities on the San Joaquin River NWR.

B. Initial or Preliminary Actions

A first action in the restoration process will be the establishment of a "cuttings nursery" for cottonwood, valley willow, arroyo willow, sandbar willow, mulefat, and coyote brush. Thousands of cuttings of each of these will be necessary each year. Plant material should be collected from a large number of individuals of each species in order to maintain a large genetic variety.

If programmatically acceptable, the farming of annual crops will provide several benefits to the restoration process. Farming of a summer crop will require the use and maintenance of the irrigation infrastructure, allowing it to remain in operating condition until restoration activities commence. Farming will also suppress the non-native weeds and reduce the build-up of weed seeds in the soil.

C. Restoration Activities to Restore the Riparian Communities

1. Unit Planning

This document provides an overview of restoration over the entire West Unit, but restoration will require an examination of each field. After funding has been secured for the restoration, a field specific unit plan should be compiled. This unit plan will describe the field-specific soil conditions, planting palette and installation pattern, details of irrigation hardware needs (pumps, tractors, and furrowing equipment), and weed control methods. In addition, a field-specific timeline for restoration activities that identifies staff responsibilities should be generated.

2. Planting Design

The placement of each tree and shrub species will be in a planned arrangement to provide different types of vegetation structure for wildlife. Using information developed by Point Reyes Bird Observatory staff, based on their work in Central Valley riparian systems, we design plant species installation patterns that can be targeted at Threatened and Endangered species identified by CALFED, and that will be useable by a variety of wildlife much sooner than offered by the Random design. For example, thickets within the forest can be designed and planted, composed of shrubs (elderberry, baccharis, arroyo willow), vines (blackberry), and creeping rye grass and basket sedge. Sacramento River Partners has developed computer software program that will generate this type of design. It produces labels that identify planting location for each individual of each species within a field.

3. Importance of Soils to Restoration Design and Success

Soil texture and profile-stratification will determine the ability of any plant to survive and grow. Willows and cottonwoods must grow their roots into the upper edge of the water table. They are not able to do this if there are lenses of pure sand, pure clay, or a hardpan in the profile, regardless of irrigation strategies. On the other hand, valley oak will grow without ever reaching a water table (although it will tap-in if possible) and it prefers fine texture loams – clay or silt loams -for best growth. Baccharis can grow on very sandy loams where most other plants cannot survive. All plants will grow and prosper on sandy loam without profile stratification and within 5-10 feet of the water table. Knowledge of the soil textural stratification across the field will allow for a planting palette and pattern that ensures a high degree of successful establishment.

The placement of the different types of riparian forest is based upon depth to water table and soil texture. Valley Willow-Buttonbush Scrub will be planted where the water table is less than 6 feet, as around the perimeter of wetlands. Mixed riparian forest will be planted where the water table is between five and ten feet deep. Valley oak forest will be planted where the water table is greater than 10 feet deep or where a layer that is impervious to root growth is encountered, e.g., Hagemann Field 25. The Clear Lake Clay under the bed of White Lake is not conducive to root growth by woody trees and shrubs and should be managed as herbaceous wetlands.

4. Proposed Restoration Implementation Sequence

a) First phase

Plant fields adjacent to existing levee breaks in the private levees on Vierra (fields V-1,2) and Hagemann (fields H-6,7,8,9) (Figure 9). These will be the first fields to suffer damage to the irrigation canals during the next high water. By planting these fields early in the process we will not need to be concerned with the future maintenance of this portion of the irrigation system. In addition, the young trees and shrubs will act to filter sediments and drift wood out of the flood waters and prevent them from impacting other fields. A summary of the fields and the number of acres restored is provided below for subsequent years.

Fields to be planted in phase 1: Vierra 1, 2, 3, and 13; Hagemann 6a, 7, and 8.
Total acres = 359

b) Second phase

Plant fields adjacent to proposed levee breaches

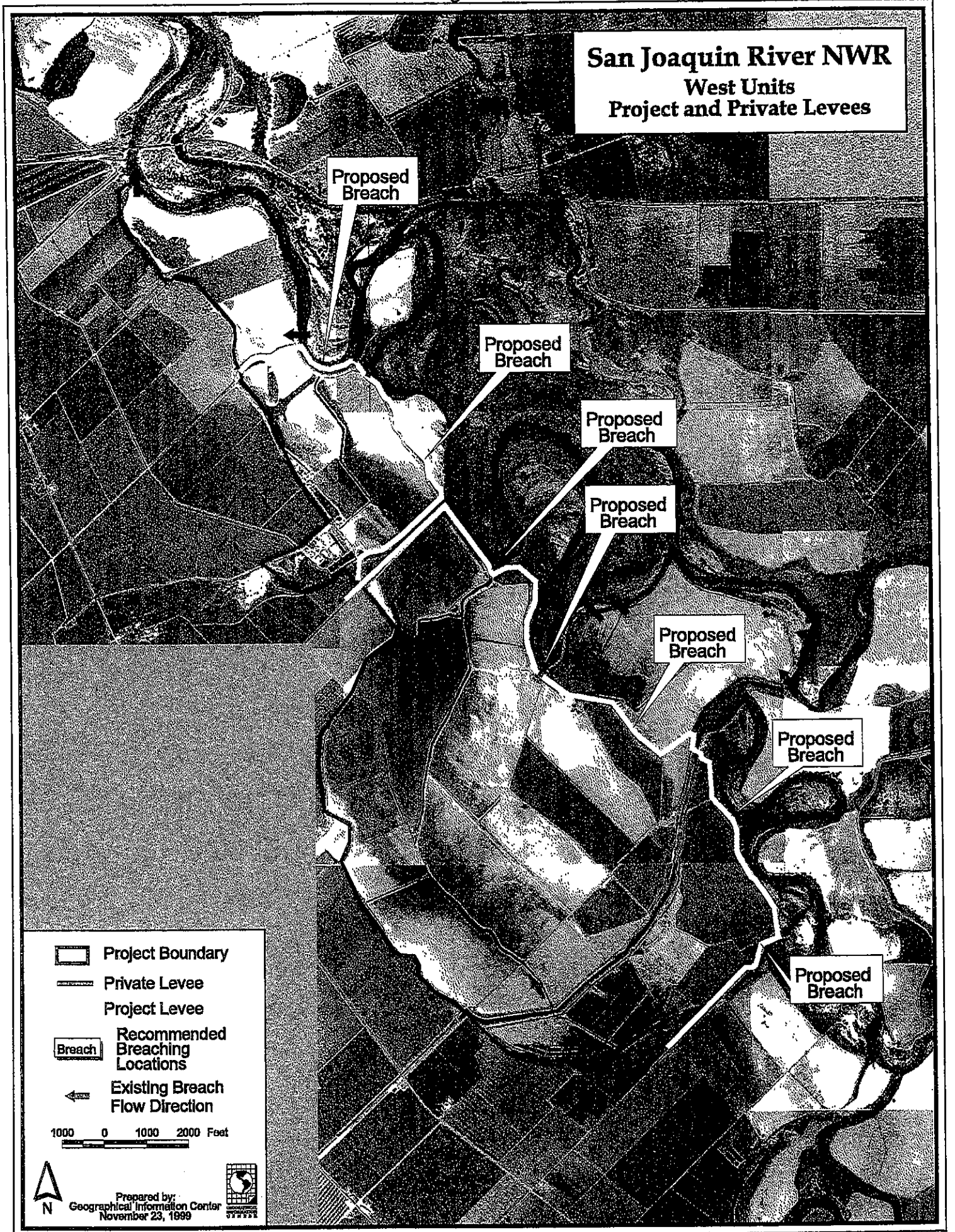
Fields to be planted in phase 2: Vierra 4, and 7; Hagemann 6b, 9, 17, 20, 21, and 18.
Total acres = 453

c) Third phase

Plant additional Hagemann fields.

Fields to be planted in phase 3: Hagemann 1, 2a, 2b, 3, 4, and 22.
Total acres = 225

Figure 9


San Joaquin River NWR
West Units
Project and Private Levees
Proposed Breach
Proposed Breach
Proposed Breach
Proposed Breach
Proposed Breach
Proposed Breach
Proposed Breach
Project Boundary
Private Levee
Project Levee
Breach
Recommended Breaching Locations
Existing Breach Flow Direction
1000 0 1000 2000 Feet
N
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Geographical Information Center
November 23, 1999

d) Fourth phase

Plant fields on Hagemann.

Fields to be planted in phase 4: Hagemann 23, 24, 25, 26, and 5.

Total acres = 257

e) Fifth phase

Complete Hagemann and Lara fields.

Fields to be planted in phase 5: Lara 3, 4, 5, 6, 7, 8, 9, and 11.

Total acres = 296.

Table 3 provides a more detailed schedule, while Figure 10 provides a map of the restoration sequence. Table 4 provides a schedule of tasks and deliverables for a typical restoration unit.

Table 3. Proposed Restoration Sequence at the West Unit of the San Joaquin NWR

Restoration Activity	Area (acres)	Start Date	Completion Date	Fields	Comments
Cutting Nursery	40	Year 1	Year 1	V8	It is important to plant the cutting nursery as soon as possible
Vierra Lake	128	Year 1	Year 1	V4, V5, V6	Wetlands* comprise 38% of Vierra property
Hagemann Lake	367	Existing	Existing	H11, H12, H13, H14, H15, H16, H17, H18, H19, H21	Wetlands comprise 61% of Hagemann property
Lara Lake	54	Year 2	Year 2	L1, L2	Wetlands comprise 24% of Lara property
Food Plot	100	November 1999	Ongoing	H18	Food plot comprises 5% of Hagemann property
Restoration Phase One	359	Year 2	Year 4	V1, V2, V3, V13, H6a, H7, H8	First year restoration implemented adjacent to existing levee breaches
Restoration Phase Two	453	Year 3	Year 5	V4, V7, H6a, H9, H17, H20, H21	Second year restoration implemented adjacent to proposed levee breaches
Restoration Phase Three	225	Year 4	Year 6	H1, H2a, H2b, H3, H4, H21, H22	Implements restoration around lakes/wetlands
Restoration Phase Four	257	Year 5	Year 7	H23, H24, H25, H26, H5	Complete restoration of Hagemann property
Restoration Phase Five	289	Year 6	Year 8	L1, L3, L4, L5, L6, L7, L8, L9	Complete restoration of Lara property

* Wetlands include areas designated as Lake (permanent) and as Buttonbush Scrub (Seasonal)

Figure 10

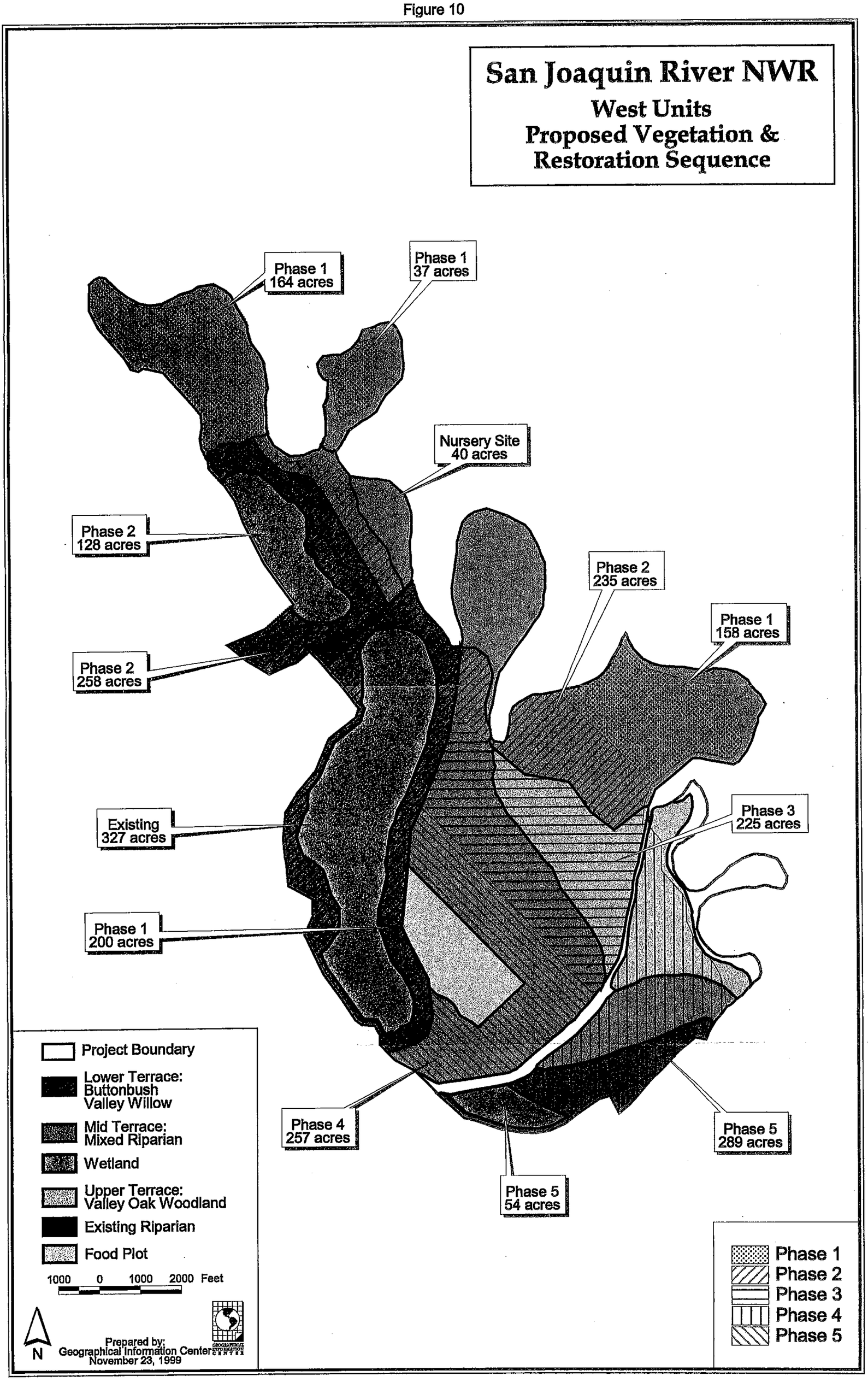
San Joaquin River NWR
West Units
Proposed Vegetation &
Restoration Sequence
Phase 1
164 acres
Phase 1
37 acres
Nursery Site
40 acres
Phase 2
128 acres
Phase 2
235 acres
Phase 1
158 acres
Phase 2
258 acres
Existing
327 acres
Phase 3
225 acres
Phase 1
200 acres
Phase 4
257 acres
Phase 5
289 acres
Phase 5
54 acres
Project Boundary
Lower Terrace:
Buttonbush
Valley Willow
Mid Terrace:
Mixed Riparian
Wetland
Upper Terrace:
Valley Oak Woodland
Existing Riparian
Food Plot
1000 0 1000 2000 Feet
N
Prepared by:
Geographical Information Center
November 23, 1999
Phase 1
Phase 2
Phase 3
Phase 4
Phase 5

Table 4. Schedule of Tasks and Deliverables for a Typical Riparian Restoration Unit on the San Joaquin River NWR

Task	Planning		Year 1			Year 2				Year 3		
	Fall	Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter	Spring	Summer
Hydrological Study												
Site Assessment												
Restoration Plan												
Plant Collection/Propagation												
Field Survey												
Field Planting												
Native Grass Planting												
Irrigation Installation												
Maintenance												
Monitoring												
Outreach												
Project Management												
Deliverables												
Site Assessment												
Restoration Plan												
Monitoring Plan												
Avian Surveys/Reports												
Planting Report												
Quarterly Progress Reports												
Annual Progress Reports												
Final Report												

V. RESTORATION TASKS

A. Site Preparation

This section describes the various tasks necessary for restoration on a typical site. The entire planting site (unit) should be disked to bury the crop stubble and weed mulch. Land-use planning may be necessary to facilitate future equipment use. Where the soil-profile is stratified, preparation of planting sites sometimes requires ripping (fracturing soil profile) or auguring (homogenizing the soil profile) to facilitate root growth.

B. Field Layout

When laying out planting rows, plan to accommodate equipment needs, such as the width of the mower that will control weeds in the aisles. Layout is traditionally in straight lines to facilitate the maneuvering of tractors and other equipment. On some projects the aesthetics of straight lines may become a political concern. One solution is to plan the straight-line planting row layout so that there are random distances between rows and between trees within the rows. The range of distances between rows and trees need only be a few feet to disrupt the visual effects of straight lines. (See planting design discussion above)

C. Planting

1. Source of Plant Material

Plant material (seeds, acorns, stem-cuttings, container stock) should all be collected from as near the planting unit as possible. This ensures that the plant material is closely related genetically and is similarly adapted to the local climate, soils, and hydrology as the plants that were originally removed from the site. Thus, plant performance will be optimized compared to material brought in from far away and the risk of genetic pollution of the local gene pool will be minimized. (Many authors in the restoration literature have discussed the genetic aspects of the source of plant material.) It is important that criteria for procuring plant material be previously agreed to by the restoration team, including the Refuge biologist. On the Sacramento River Project, we used the following criteria: All plant material must originate from parent plants that 1. grow on the main stem of the Sacramento River; 2. Grow on the Columbia Soil Series; 3. Grow as close as possible to the planting site after 1 & 2 have been satisfied. We propose that plant material for restoration on the San Joaquin River NWR come from sources as near the Refuge as possible, on floodprone lands. Perhaps the lower Stanislaus and Tuolumne Rivers west of Highway 99 could be included.

2. Propagation Alternatives

Numbers of individual plants: we recommend an initial planting density of 200 to 300 woody plants per acre. Another 200 plugs per acre of basket sedge and creeping rye should be planted during the final year of maintenance, to avoid herbicide death during the first year or two. At a planting density of 200 per acre, 20,000 individuals of woody plants will be needed to plant 100 acres. The production of this number plants is a full-time job for more than one person, utilizing modern facilities: greenhouse, shadehouse, and irrigation systems. This will not be accomplished using part-time staff or volunteers. Therefore, a commercial plant nursery operation should be contracted to produce the

plant material. However, local staff should be responsible for the collection of seeds, acorns, and cuttings to be delivered to the commercial nursery, since they know the local neighborhood where these materials should be collected.
Each species has its own distinctive requirements for successful propagation. The propagation methodology for each species is described in detail in the "Riparian Forest Restoration Manual - 1998" based upon the experience on the Sacramento River.

Cottonwood, willows, and baccharis are propagated by one-year old stem cuttings, placed into the soil where they will grow or into one-gallon containers and grown out until their roots have filled the container, then transplanted into the field. **An important early task for restoring the refuge will be the establishment of a "cuttings nursery" for production of cuttings to be used over the entire 1,623 acres through future years. There are not enough cottonwood, arroyo willow, or baccharis near the Refuge to provide this number without seriously impacting the few natural stands.** A vigorously growing two-year old cottonwood or willow will provide many cuttings. The stump will resprout the following spring and produce even more material the following year.

Valley oak is best planted using acorns collected the previous fall. These must be collected from the tree and stored under refrigeration until planted in the fall after the onset of rain. It is important to plant acorns in the fall as they immediately begin growing a taproot that will be 12"-24" long by late March when the stem and leaves emerge from the soil.

Box-elder, ash, elderberry, basket sedge, creeping rye, blackberry (cutting), buttonbush, rose should be grown in containers in a nursery to produce vigorous plants at the time of installation.

3. Plant Protectors

Plant protectors should be placed on the seedlings or cuttings at the time of planting into the field. We recommend Milk Cartons because they are cheap and effective for protection from herbicide drift. They should be used only with vigorously growing seedlings since light enters only from the top, not the sides as with blue-x and tube-x, resulting in relatively dark conditions at the bottom of the carton.

D. Irrigation

The goal of the irrigation strategy is for the tree sapling to become self-sufficient by the end of the third season.

1. Irrigation Strategies

a) First season

All species grow vigorously with moist soil in their rooting zone during the first growing season. The seedling trees have roots only in the surface one or two feet of the soil profile. The rooting zone must be kept moist through the season to ensure optimum growth. On loam soils, a frequency of once every 10 days is sufficient.

b) Second and third seasons

The strategy for the second year is to train the roots to grow deep. By applying enough water to moisten the soil at depth (5-15 feet), roots will grow towards the deep, moist soil, well below the roots of the weeds, allowing the tree exclusive use of this deep moisture. As the tree's roots grow deeper, the times between irrigations become longer (4-8 weeks in year 2, 3-4 months in year 3). The interval between irrigations is dependent upon soil texture. Soil surface layers dry between irrigations, thereby reducing the vigor of weeds.

2. Flood Irrigation

A functional flood-irrigation system exists on the agricultural fields covered by this report. Flood irrigation applies water to the entire unit resulting in a deep irrigation and the growth of plenty of weeds. This method should result in deep penetration of irrigation water to promote deep root growth. Hardware costs are the lowest compared to drip or sprinklers with only a well and a low-pressure, high volume pump required. A tractor with furrow implements must be available throughout the season to maintain the canals and furrows needed to deliver the water. The major cost of a flood irrigation system is the vigorous growth of abundant weeds throughout the field.

3. Soil Moisture Monitoring

Monitoring of the moisture levels down the soil profile is accomplished by placing several gypsum blocks at 3-4 ft. intervals in the profile. An alternative method is to monitor the development of drought indicators on the trees.

E. Weed Control

Not only do weeds compete for light, soil moisture and nutrients, but they also provide cover for herbivorous rodents.

1. Weed Control Strategies

The overall goal of a weed control program is to minimize the impacts of weeds upon the planted trees. As long as the saplings are growing vigorously, then whatever weeds that are present can be viewed as having a benign effect. However, weeds are also cover for rodent pests. As the density of weeds increases over the first 2-3 years, rodent populations increase dramatically. At the San Joaquin River NWR, the goal of weed control will be to lower rodent numbers.

a) First season

During the first season weeds should be controlled aggressively. At the time of planting, there should be few if any weeds on the unit. This level of control allows for easy access to all parts of the field, and assures that few, if any, rodents are present at the time of planting.

b) Second and third seasons

During the second and third seasons weed control is relaxed, as most saplings have grown sufficiently to be taller than most weeds and their roots have grown below the rooting zone of the weeds. If the costs of weed control can be absorbed, then

aggressively controlling weeds during the second and third season will result in more growth for the saplings and less rodent damage. For example, in alfalfa fields alfalfa and weeds must be controlled repeatedly around the saplings for the life of the crop (5 years) because of the rodent issue.

2. Weed Control Techniques

a) Weed mats (vegetation mats)

Weed or vegetation mats are composed of either woven plastic or wax paper. They can be purchased in a variety of dimensions, we use 3 ft. x 3 ft. or 4 ft. x 4 ft. Weed mats are effective at suppressing germination of weed seeds. Paper mats are effective for only the first season, as they decompose by fall, which may be all that is required. Plastic mats can last for many years, longer than the need for weed control. Installation of weed mats is labor intensive, adding several minutes per site at planting time.

b) Herbicides

Herbicides are an essential tool in our restoration program. Use of herbicides reduces the overall cost of weed control compared to using exclusively mechanical methods. Herbicides are the most efficient method of clearing aisles, keeping valves and irrigation lines clear, and for spot-application around restoration trees.

c) Mowing

Mowing is effective at keeping the aisle between tree rows open for access. In year 2 and 3 mowing may be all that is required for weed control, if the trees have attained sufficient height (1-2 feet). Mowing an aisle usually allows more light to reach the saplings.

d) Disking

Disking is effective for cleaning the unit before planting. Disking buries weed mulch, which destroys cover for rodents, and it also destroys rodent burrow systems. Be aware that disking will mix the soil weed seed bank, resulting in a dense seedling stand of weeds whenever rain or irrigation is applied.

F. Herbivore Control

1. Control Strategies

Adjust the plant to herbivore ratio to favor the plants by either planting more individuals than can be eaten by an herbivore, or by reducing the herbivore population through any of the following methods:

a. Remove weedy mulch from the unit by farming, fallow disking, mowing, or applying herbicides.
b. Install raptor perches and Barn-owl boxes.

2. Deer

Deer will repeatedly browse a sapling, essentially pruning it and preventing it from growing into a tree. However, browsing has not been observed to kill a tree. Only sycamore and sandbar willow appear immune from deer browse. Experiments carried out at Kopta Slough showed that any type of physical protection - plastic screens or chicken wire - protected saplings better than any of the commercially available repellents

(we have tried "Repel", "Big Game Repellent", "HotSauce"). Hot Sauce was used with success on cottonwood and willow at Kopta Slough in 1990. The most effective method, however, is to plant more trees than the deer can eat. This, of course, is a function of the size of the local deer herd.

Antler rubbing by male deer in September on saplings can impact a large number. In the process of rubbing the velvet off their antlers, they also rub the cambium off the stem, killing it. However, saplings typically resprout new stems the following spring.

3. Voles (*Microtus*)

Voles can be the most abundant rodent species on a site. Voles are rarely seen clearly as they live only in a dense herbaceous (weed) cover and never stop moving when in the open. Voles damage saplings by eating the bark and cambium at the base of a sapling, usually girdling the entire stem. Saplings often resprout from such damage; however if the vole population is high, the resprouts will be eaten also. Voles will dig-up recently planted acorns and eat them. Control of voles is best accomplished by removing dense weed cover through herbicides or mowing.

4. Pocket Gophers (*Thomomys bottae*)

Pocket gophers probably kill more saplings than any other vertebrate pest by eating the root systems. Control of weed cover allows predators to hunt gophers; however, gophers can persist in an open, weed-free field. Gophers especially favor alfalfa. Control of gopher populations is by frequent disking, weed mulch control, or poison baits. Gophers are the favorite prey item for barn owls. Wintering hawks, harriers, eagles, great blue herons, and egrets will take gophers if given the opportunity. Installation of raptor perches shows promise, but needs more seasons of observation to refine this method.

5. Ground Squirrels (Otospermophilus beecheyi)

Ground squirrels are potentially the most destructive rodent because of their behavior of digging up plants and protectors and shredding them. They will eat the bark of willow and cottonwood saplings and limbs. Control by anticoagulant baits is effective.

6. Rabbits and Hares

Rabbits and hares have been a problem only in the very early spring when they browse early growth. Most seedlings resprout.

7. Beavers

Beavers can clear-cut a stand of willows and cottonwoods. However, they appear to be restricted in the distance they can safely range away from open water - about 200 feet. There are likely more beaver in the river today than in pristine times due to the altered hydrology.

G. Monitoring

The monitoring methodology of a restoration planting unit must be clearly defined at the beginning of the project. Monitoring is essential in order to demonstrate the success of the project (see next section) or any task. Personnel who are qualified to carry out

monitoring must be identified at the beginning of the project. For example, staff members that implement the planting are qualified to monitor the technical and the horticultural aspects, but may not be the right people to monitor and evaluate bird-use.

1. During Season Monitoring- Monitoring of implementation tasks (irrigation, weed control, gypsum blocks) and the responses of the trees should be carried out at least once or twice per month.

2. End of Season Monitoring- Compiled at the end of the growing season and documents annual survival of each species and their growth. Our end of season monitoring program will attempt to sample between five and ten percent of the unit. On smaller units, a complete census may be feasible. The end of season report presents the following measurements and statistics.

Survival reported as density of each species per acre.
Growth of each species as measured by height.
Cover as expressed as a percent of the entire unit for each species.

3. Wildlife-use during the first season can be measured as herbivore browsing and rodent damage to the planted trees. As the planting grows and develops structure and cover, wildlife should colonize and begin to utilize the unit. Use by birds is an indicator that the restoration planting is functioning in an ecologically similar manner to a natural forest. Many bird species are secondary consumers on the food pyramid of the riparian forest; that is, birds, such as warblers, forage for insects (the primary consumers) that were supported by the trees that we planted.

Since 1994 the Point Reyes Bird Observatory (PRBO) staff have been monitoring bird use of naturally occurring stands of riparian forest as well as restoration units on the Sacramento River. Point counts, nest monitoring, and quantified vegetation descriptions have generated baseline conditions for many species populations and recommendations for modifications of the planting design of restoration units. Monitoring by PRBO in 1996 showed that Kopta Slough restoration units – 5 to 6 years old at the time – supported equivalent species diversity as natural stands of riparian forest. In 1998 the western yellow-billed cuckoo (State listed as endangered) nested at two restoration units that were 8 to 10 years old. Similar monitoring by PRBO on the San Joaquin National Wildlife Refuge would be very valuable.

H. Long Term Management of Restoration Plantings:

The goal of implementation management is self-sustaining riparian communities. This means that at the end of the maintenance period the trees and shrubs are sufficiently large enough to persist through the summer droughts on their own, whether through inherent drought-tolerance or by having grown roots into the surface of the water table. Careful monitoring will reveal the success of achieving this goal by the end of the maintenance period. Over the long term, the riparian plantings are expected to regenerate themselves, in response to the physical processes of the river, and maintain high-quality riparian habitat for wildlife.

The only possible future catastrophe that may reduce the quality of the riparian habitat would be a wildfire. The existing network of roads on the Refuge could function as a system of firebreaks to protect the habitat from destruction. Roads are the ONLY means of stopping a wildfire in the riparian forest. Examples: Ed Hagemann experience: during the wildfire 10 years ago, a crown fire developed which halted suppression efforts; At Kopta Slough on the Sacramento River in February 1991 a wildfire consumed 120 acres of cottonwood forest. Suppression was only possible by backfiring off an existing road and by the lack of wind. At the Bobelaine preserve (Audubon Society) on the Feather River in September 1991 a wildfire was allowed to burn itself out at the river's edge and at the project levees because of the large fuel loads, crown fire, and uneven terrain which was determined to be too dangerous for fire-fighters.

VI. BUDGETS

A. Budget Considerations

Budgeting for a multi-phase, multi-million dollar project such as this can be complex. In an effort to simplify this effort the budgets are presented in the following format:

1. Cost per single acre. This budget divides the cost of a hypothetical 100-acre restoration project by 100 to provide typical per acre costs. Breaking the budget down in this fashion defines the proportional relationships between line items. The cost per single acre budget is presented as Table 5.

2. Consolidated Restoration. This budget extends the per acre budget to cover the entire 1623 acres projected to be restored. Also, captured in this budget are over all project cost such as cultural and NEPA compliance reporting. This budget is presented as Table 6 and represents the projected total cost of all phases of the project.

3. Phase 1-5 Restoration. These are stand-alone budgets that encompass all expenses associated with implementing each specific restoration phase (each phase has a three year lifecycles). Combining Figure 10 with these budgets (Tables 7-11) provides an overview of the funds required for restoration of delineated areas of the refuge.

4. Cutting Nursery. This budget details the expenses of establishing a cutting nursery, for cottonwood and willow propagation, during the first year. This budget is presented as Table 12.

B. Interpreting the Project Budgets.

The condition of the project's existing agricultural infrastructure will significantly affect restoration costs. The grade and slope of the fields, integrity of pipelines, ditches and drains, and functionality of the wells, pumps, and motors have been assumed to be in good working order. If these fields are farmed prior to reforestation the lessees will be responsible for maintaining this infrastructure. Another important consideration in evaluating irrigation equipment is safety. Equipment such as electrical panels without lockouts, unsafe interior standpipe ladders, and improvised valves simply require replacement. These provisions have been budgeted under irrigation startup.

Project planning and permitting costs include a hydraulic study to satisfy the California State Reclamation Board. Additionally, each phase of the restoration will require individual site assessments and unit plans that detail plant communities, plant densities, specie composition, and distribution. For the purpose of these budgets we have assumed the woody plant density at 280 trees per acre. Native grass restoration that is planted between the tree rows is presented as a separate line item in each budget.

Commitment to local plant sources requires collecting seeds and cuttings as close to the restoration site as possible as well as training and contracting local nurseries to process and propagate the plant material. Costs also include replants in years 2 and 3.

Both vegetative and avian monitoring costs are included in this line item. Each restoration site will have a complete plant census to determine survivorship, growth, and cover in years 1, 2, and 3. Songbird monitoring involves fixed radius point counts, nest monitoring, area search census and habitat/vegetation assessment.

Reporting costs per phase for phases 1-5 include a restoration unit plan, planting report, end of season reports (3), and a project completion report.

Table 5. Estimated Restoration Costs per Acre Based on a 100 Acre Unit Located on the West Unit of the San Joaquin NWR

Task	Direct Labor Hours	Direct Salary	Service Contracts	Material Costs	Miscellaneous and other Direct Costs	Overhead and Indirect Costs	Total Cost
Hydrologic Study	0.31	$ 9.27	$ 60.00	$ -	$ -	$ 13.85	$ 83.13
Site Assessment	0.57	$ 17.05	$ 4.00	$ 2.00	$ 5.00	$ 5.61	$ 33.66
Restoration Plan	0.6	$ 17.95	$ 13.00	$ 3.00	$ 7.00	$ 8.19	$ 49.14
Plant Prorogation	0.6	$ 17.95	$ 30.00	$ 438.00	$ 10.00	$ 99.19	$ 595.14
Field Survey/Layout	0.6	$ 17.95	$ 25.00	$ 2.00	$ 9.00	$ 10.79	$ 64.74
Irrigation Repair/Startup	0.75	$ 22.43	$ 150.00	$ -	$ 4.80	$ 35.45	$ 212.68
Field Planting	1.91	$ 57.13	$ 645.00	$ 20.00	$ 110.00	$ 166.43	$ 998.56
Maintenance	6	$ 179.47	$ 800.00	$ 150.00	$ 84.00	$ 242.69	$ 1,456.17
Monitoring/Reporting	5.76	$ 172.29	$ 40.00	$ 6.00	$ 12.00	$ 46.06	$ 276.35
Outreach	0.66	$ 19.74	$ 22.50	$ 4.00	$ 4.00	$ 10.05	$ 60.29
Project Management	18	$ 538.42	$ 34.00	$ -	$ 12.00	$ 116.88	$ 701.30
Totals	**34.28**	**$ 1,069.65**	**$ 1,823.50**	**$ 625.00**	**$ 257.80**	**$ 755.19**	**$ 4,531.14**
Native Grass Planting	0.75	$ 22.43	$ 150.00	$ 510.00	$ 0.75	$ 136.64	$ 819.82
Combined Totals	**35.03**	**$ 1,092.09**	**$ 1,973.50**	**$ 1,135.00**	**$ 258.55**	**$ 891.83**	**$ 5,350.96**

Table 6. Consolidated Budget for the San Joaquin River NWR Restoration Phases 1-5 (Total Restored Acres 1,623)

Task	Direct Labor Hours	Direct Salary	Service Contracts	Material Costs	Miscellaneous and other Direct Costs	Overhead and Indirect Costs	Total Cost
Hydrologic Study	503	$ 15,050	$ 97,380	$ -	$ -	$ 22,486	$ 134,916
Site Assessment	925	$ 27,672	$ 6,492	$ 3,246	$ 8,115	$ 9,105	$ 54,630
Restoration Plan	974	$ 29,128	$ 21,099	$ 4,869	$ 11,361	$ 13,291	$ 79,749
Plant Propagation	974	$ 29,128	$ 48,690	$ 710,874	$ 16,230	$ 160,984	$ 965,907
Field Survey/Layout	974	$ 29,128	$ 40,575	$ 3,246	$ 14,607	$ 17,511	$ 105,068
Irrigation Repair	1217	$ 36,410	$ 243,450	$ -	$ 7,790	$ 57,530	$ 345,181
Field Planting	3100	$ 92,725	$ 1,046,835	$ 32,460	$ 178,530	$ 270,110	$ 1,620,660
Maintenance	9738	$ 291,283	$ 1,298,400	$ 243,450	$ 136,332	$ 393,893	$ 2,363,358
Monitoring	9348	$ 279,632	$ 64,920	$ 9,738	$ 19,476	$ 74,753	$ 448,519
Outreach	1071	$ 32,041	$ 36,518	$ 6,492	$ 6,492	$ 16,309	$ 97,851
Project Management	29214	$ 873,849	$ 55,182	$ -	$ 19,476	$ 189,701	$ 1,138,209
Totals	**58038**	**$ 1,736,047**	**$ 2,959,541**	**$ 1,014,375**	**$ 418,409**	**$ 1,225,674**	**$ 7,354,046**
Native Grass Planting	1217	$ 36,410	$ 243,450	$ 827,730	$ 1,217	$ 221,762	$ 1,330,569
Cutting Nursery	1138	$ 34,052	$ 67,880	$ 24,520	$ 9,472	$ 27,185	$ 164,247
Culture Resource Compliance	300	$ 8,974	$ 49,400	$ 2,300	$ 1,770	$ 12,489	$ 74,932
NEPA Compliance Reports	200	$ 5,982	$ 5,000	$ 1,150	$ 725	$ 2,571	$ 15,429
Levee Breaching	497	$ 14,866	$ 50,000	$ 3,500	$ 15,000	$ 16,673	$ 100,040
Consolidated Totals	**61391**	**$ 1,836,331**	**$ 3,375,271**	**$ 1,873,575**	**$ 446,594**	**$ 1,506,354**	**$ 9,039,263**

Assumptions: Area to be restored has a functional flood irrigation system. Woody species will be planted at a density of 280 plants per acre. All costs reflect a three-year cultivation period - plant in year one and maintenance in years two and three. Monitoring includes tree survivorship in year 1, 2, and 3 and songbird monitoring (fixed radius point counts, nest monitoring, area search census, and habitat/vegetation assessment). Reports budgeted include a restoration unit plan, planting report, end of season reports (3), and project completion report. Plant Propagation captures all cost associated with seed and cutting collecting, processing, cold storage, nursery propagation of potted stock.

Table 7. Budget for Phase 1 of the Proposed San Joaquin River NWR Restoration (Restored Acres for Phase: 359)

Task	Direct Labor Hours	Direct Salary	Service Contracts	Material Costs	Miscellaneous and other Direct Costs	Overhead And Indirect Costs	Total Cost
Hydrologic Study	111.29	$ 3,329	$ 21,540	$ -	$ -	$ 4,974	$ 29,843
Site Assessment	204.63	$ 6,121	$ 1,436	$ 718	$ 1,795	$ 2,014	$ 12,084
Restoration Plan	215.4	$ 6,443	$ 4,667	$ 1,077	$ 2,513	$ 2,940	$ 17,640
Plant Propagation	215.4	$ 6,443	$ 10,770	$ 157,242	$ 3,590	$ 35,609	$ 213,654
Field Survey/Layout	215.4	$ 6,443	$ 8,975	$ 718	$ 3,231	$ 3,873	$ 23,240
Irrigation Repair	269.25	$ 8,054	$ 53,850	$ -	$ 1,723	$ 12,725	$ 76,352
Field Planting	685.69	$ 20,510	$ 231,555	$ 7,180	$ 39,490	$ 59,747	$ 358,482
Maintenance	2154	$ 64,430	$ 287,200	$ 53,850	$ 30,156	$ 87,127	$ 522,764
Monitoring	2067.84	$ 61,853	$ 14,360	$ 2,154	$ 4,308	$ 16,535	$ 99,210
Outreach	236.94	$ 7,087	$ 8,078	$ 1,436	$ 1,436	$ 3,607	$ 21,644
Project Management	6462	$ 193,291	$ 12,206	$ -	$ 4,308	$ 41,961	$ 251,766
Totals	**12837.84**	**$ 384,005**	**$ 654,637**	**$ 224,375**	**$ 92,550**	**$ 271,113**	**$ 1,626,681**
Native Grass Planting	269.25	$ 8,054	$ 53,850	$ 183,090	$ 269	$ 49,053	$ 294,316
Consolidated Totals	**13107.09**	**$ 392,059**	**$ 708,487**	**$ 407,465**	**$ 92,819**	**$ 320,166**	**$ 1,920,996**

Assumptions: Area to be restored has a functional flood irrigation system. Woody species will be planted at a density of 280 plants per acre. All costs reflect a three-year cultivation period - plant in year one and maintenance in years two and three. Monitoring includes tree survivorship in year 1, 2, and 3 and songbird monitoring (fixed radius point counts, nest monitoring, area search census, and habitat/vegetation assessment). Reports budgeted include a restoration unit plan, planting report, end of season reports (3), and project completion report. Plant Propagation captures all cost associated with seed and cutting collecting, processing, cold storage, nursery propagation of potted stock.

Table 8. Budget for Phase 2 of the Proposed San Joaquin River NWR Restoration (Restored Acres for Phase: 453)

Task	Direct Labor Hours	Direct Salary	Service Contracts	Material Costs	Miscellaneous and other Direct Costs	Overhead and Indirect Costs	Total Cost
Hydrologic Study	140.43	$ 4,201	$ 27,180	$ -	$ -	$ 6,276	$ 37,657
Site Assessment	258.21	$ 7,724	$ 1,812	$ 906	$ 2,265	$ 2,541	$ 15,248
Restoration Plan	271.8	$ 8,130	$ 5,889	$ 1,359	$ 3,171	$ 3,710	$ 22,259
Plant Propagation	271.8	$ 8,130	$ 13,590	$ 198,414	$ 4,530	$ 44,933	$ 269,597
Field Survey/Layout	271.8	$ 8,130	$ 11,325	$ 906	$ 4,077	$ 4,888	$ 29,326
Irrigation Repair	339.75	$ 10,163	$ 67,950	$ -	$ 2,174	$ 16,057	$ 96,344
Field Planting	865.23	$ 25,881	$ 292,185	$ 9,060	$ 49,830	$ 75,391	$ 452,347
Maintenance	2718	$ 81,301	$ 362,400	$ 67,950	$ 38,052	$ 109,941	$ 659,643
Monitoring	2609.28	$ 78,049	$ 18,120	$ 2,718	$ 5,436	$ 20,865	$ 125,187
Outreach	298.98	$ 8,943	$ 10,193	$ 1,812	$ 1,812	$ 4,552	$ 27,312
Project Management	8154	$ 243,902	$ 15,402	$ -	$ 5,436	$ 52,948	$ 317,689
Totals	**16199.28**	**$ 484,553**	**$ 826,046**	**$ 283,125**	**$ 116,783**	**$ 342,101**	**$ 2,052,608**
Native Grass Planting	339.75	$ 10,163	$ 67,950	$ 231,030	$ 340	$ 61,896	$ 371,379
Consolidated Totals	**16539.03**	**$ 494,715**	**$ 893,996**	**$ 514,155**	**$ 117,123**	**$ 403,998**	**$ 2,423,987**

Assumptions: Area to be restored has a functional flood irrigation system. Woody species will be planted at a density of 280 plants per acre. All costs reflect a three-year cultivation period - plant in year one and maintenance in years two and three. Monitoring includes tree survivorship in year 1, 2, and 3 and songbird monitoring (fixed radius point counts, nest monitoring, area search census, and habitat/vegetation assessment). Reports budgeted include a restoration unit plan, planting report, end of season reports (3), and project completion report. Plant Propagation captures all cost associated with seed and cutting collecting, processing, cold storage, nursery propagation of potted stock.

Table 9. Budget for Phase 3 of the Proposed San Joaquin River NWR Restoration (Restored Acres for Phase: 225)

Task	Direct Labor Hours	Direct Salary	Service Contracts	Material Costs	Miscellaneous and other Direct Costs	Overhead and Indirect Costs	Total Cost
Hydrologic Study	69.75	$ 2,086	$ 13,500	$ -	$ -	$ 3,117	$ 18,704
Site Assessment	128.25	$ 3,836	$ 900	$ 450	$ 1,125	$ 1,262	$ 7,573
Restoration Plan	135	$ 4,038	$ 2,925	$ 675	$ 1,575	$ 1,843	$ 11,056
Plant Propagation	135	$ 4,038	$ 6,750	$ 98,550	$ 2,250	$ 22,318	$ 133,906
Field Survey/Layout	135	$ 4,038	$ 5,625	$ 450	$ 2,025	$ 2,428	$ 14,566
Irrigation Repair	168.75	$ 5,048	$ 33,750	$ -	$ 1,080	$ 7,976	$ 47,853
Field Planting	429.75	$ 12,855	$ 145,125	$ 4,500	$ 24,750	$ 37,446	$ 224,676
Maintenance	1350	$ 40,381	$ 180,000	$ 33,750	$ 18,900	$ 54,606	$ 327,637
Monitoring	1296	$ 38,766	$ 9,000	$ 1,350	$ 2,700	$ 10,363	$ 62,179
Outreach	148.5	$ 4,442	$ 5,063	$ 900	$ 900	$ 2,261	$ 13,565
Project Management	4050	$ 121,144	$ 7,650	$ -	$ 2,700	$ 26,299	$ 157,792
Totals	**8046**	**$ 240,672**	**$ 410,288**	**$ 140,625**	**$ 58,005**	**$ 169,918**	**$ 1,019,507**
Native Grass Planting	168.75	$ 5,048	$ 33,750	$ 114,750	$ 169	$ 30,743	$ 184,460
Consolidated Totals	**8214.75**	**$ 245,720**	**$ 444,038**	**$ 255,375**	**$ 58,174**	**$ 200,661**	**$ 1,203,967**

Assumptions: Area to be restored has a functional flood irrigation system. Woody species will be planted at a density of 280 plants per acre. All costs reflect a three-year cultivation period - plant in year one and maintenance in years two and three. Monitoring includes tree survivorship in year 1, 2, and 3 and songbird monitoring (fixed radius point counts, nest monitoring, area search census, and habitat/vegetation assessment). Reports budgeted include a restoration unit plan, planting report, end of season reports (3), and project completion report. Plant Propagation captures all cost associated with seed and cutting collecting, processing, cold storage, nursery propagation of potted stock.

Table 10. Budget for Phase 4 of the Proposed San Joaquin River NWR Restoration (Restored Acres for Phase: 257)

Task	Direct Labor Hours	Direct Salary	Service Contracts	Material Costs	Miscellaneous and other Direct Costs	Overhead and Indirect Costs	Total Cost
Hydrologic Study	79.67	$ 2,383	$ 15,420	$ -	$ -	$ 3,561	$ 21,364
Site Assessment	146.49	$ 4,382	$ 1,028	$ 514	$ 1,285	$ 1,442	$ 8,651
Restoration Plan	154.2	$ 4,612	$ 3,341	$ 771	$ 1,799	$ 2,105	$ 12,628
Plant Propagation	154.2	$ 4,612	$ 7,710	$ 112,566	$ 2,570	$ 25,492	$ 152,950
Field Survey/Layout	154.2	$ 4,612	$ 6,425	$ 514	$ 2,313	$ 2,773	$ 16,637
Irrigation Repair	192.75	$ 5,766	$ 38,550	$ -	$ 1,234	$ 9,110	$ 54,659
Field Planting	490.87	$ 14,683	$ 165,765	$ 5,140	$ 28,270	$ 42,772	$ 256,629
Maintenance	1542	$ 46,124	$ 205,600	$ 38,550	$ 21,588	$ 62,372	$ 374,235
Monitoring	1480.32	$ 44,279	$ 10,280	$ 1,542	$ 3,084	$ 11,837	$ 71,022
Outreach	169.62	$ 5,074	$ 5,783	$ 1,028	$ 1,028	$ 2,582	$ 15,495
Project Management	4626	$ 138,373	$ 8,738	$ -	$ 3,084	$ 30,039	$ 180,234
Totals	**9190.32**	**$ 274,901**	**$ 468,640**	**$ 160,625**	**$ 66,255**	**$ 194,084**	**$ 1,164,504**
Native Grass Planting	192.75	$ 5,766	$ 38,550	$ 131,070	$ 193	$ 35,116	$ 210,694
Consolidated Totals	**9383.07**	**$ 280,666**	**$ 507,190**	**$ 291,695**	**$ 66,447**	**$ 229,200**	**$ 1,375,198**

Assumptions: Area to be restored has a functional flood irrigation system. Woody species will be planted at a density of 280 plants per acre. All costs reflect a three-year cultivation period - plant in year one and maintenance in years two and three. Monitoring includes tree survivorship in year 1, 2, and 3 and songbird monitoring (fixed radius point counts, nest monitoring, area search census, and habitat/vegetation assessment). Reports budgeted include a restoration unit plan, planting report, end of season reports (3), and project completion report. Plant Propagation captures all cost associated with seed and cutting collecting, processing, cold storage, nursery propagation of potted stock.

Table 11. Budget for Phase 5 of the Proposed San Joaquin River NWR Restoration (Restored Acres for Phase: 289)

Task	Direct Labor Hours	Direct Salary	Service Contracts	Material Costs	Miscellaneous and other Direct Costs	Overhead and Indirect Costs	Total Cost
Hydrologic Study	89.59	$ 2,680	$ 17,340	$ -	$ -	$ 4,004	$ 24,024
Site Assessment	164.73	$ 4,927	$ 1,156	$ 578	$ 1,445	$ 1,621	$ 9,728
Restoration Plan	173.4	$ 5,187	$ 3,757	$ 867	$ 2,023	$ 2,367	$ 14,200
Plant Propagation	173.4	$ 5,187	$ 8,670	$ 126,582	$ 2,890	$ 28,666	$ 171,994
Field Survey/Layout	173.4	$ 5,187	$ 7,225	$ 578	$ 2,601	$ 3,118	$ 18,709
Irrigation Repair	216.75	$ 6,483	$ 43,350	$ -	$ 1,387	$ 10,244	$ 61,465
Field Planting	551.99	$ 16,511	$ 186,405	$ 5,780	$ 31,790	$ 48,097	$ 288,583
Maintenance	1734	$ 51,867	$ 231,200	$ 43,350	$ 24,276	$ 70,139	$ 420,832
Monitoring	1664.64	$ 49,793	$ 11,560	$ 1,734	$ 3,468	$ 13,311	$ 79,866
Outreach	190.74	$ 5,705	$ 6,503	$ 1,156	$ 1,156	$ 2,904	$ 17,424
Project Management	5202	$ 155,602	$ 9,826	$ -	$ 3,468	$ 33,779	$ 202,675
Totals	**10334.64**	**$ 309,130**	**$ 526,992**	**$ 180,625**	**$ 74,504**	**$ 218,250**	**$ 1,309,501**
Native Grass Planting	216.75	$ 6,483	$ 43,350	$ 147,390	$ 217	$ 39,488	$ 236,928
Consolidated Totals	**10551.39**	**$ 315,613**	**$ 570,342**	**$ 328,015**	**$ 74,721**	**$ 257,738**	**$ 1,546,429**

Assumptions: Area to be restored has a functional flood irrigation system. Woody species will be planted at a density of 280 plants per acre. All costs reflect a three-year cultivation period - plant in year one and maintenance in years two and three. Monitoring includes tree survivorship in year 1, 2, and 3 and songbird monitoring (fixed radius point counts, nest monitoring, area search census, and habitat/vegetation assessment). Reports budgeted include a restoration unit plan, planting report, end of season reports (3), and project completion report. Plant Propagation captures all cost associated with seed and cutting collecting, processing, cold storage, nursery propagation of potted stock.

Table 12. Budget for the Cutting Nursery to Support Restoration Efforts at the West Unit of the San Joaquin River NWR

Task	Direct Labor Hours	Direct Salary	Service Contracts	Material Costs	Miscellaneous and other Direct Costs	Overhead and Indirect Costs	Total Cost
Restoration Plan	24	$ 718	$ 520	$ 120	$ 280	$ 328	$ 1,965
Plant Propagation	24	$ 718	$ 1,200	$ 17,520	$ 400	$ 3,968	$ 23,805
Field Survey/Layout	24	$ 718	$ 1,000	$ 80	$ 360	$ 432	$ 2,589
Irrigation Repair	30	$ 897	$ 6,000	$ -	$ 192	$ 1,418	$ 8,507
Field Planting	76.4	$ 2,285	$ 25,800	$ 800	$ 4,400	$ 6,657	$ 39,942
Maintenance	240	$ 7,179	$ 32,000	$ 6,000	$ 3,360	$ 9,708	$ 58,247
Project Management	720	$ 21,537	$ 1,360	$ -	$ 480	$ 4,675	$ 28,052
Totals	**1138.4**	**$ 34,052**	**$ 67,880**	**$ 24,520**	**$ 9,472**	**$ 27,185**	**$ 163,109**

VII. CONCLUSIONS

The Non-Structural Flood Demonstration Project on the San Joaquin National Wildlife Refuge has basic physical features that qualify the site as a unique and outstanding restoration site.

- The location of the site - at the confluence of the San Joaquin and Tuolumne Rivers, two of the most heavily impacted streams in California, makes the Non-Structural Flood Demonstration Project one of the most biologically important and potentially visible restoration efforts in the State of California.

- The typography of the site – 3166 riparian acres lying at elevations below neighboring farmlands - makes the site a self-contained flood plain/meanderbelt that can be managed without flood threat to neighbors. This in itself constitutes a veritable field-scale laboratory for river restoration work. This opportunity is underlined by plans for levee breaches that will complete river connectivity to the flood plain.

- The size and quality of the site – 3166 contiguous acres – makes focused restoration of the site possible so that effective habitat can be achieved for species that have been locally eliminated or otherwise heavily impacted by previous intensive farming. The soil quality of the site makes successful habitat restoration feasible and predictable.

In addition to the major physical attributes of the site listed above, there are other considerations that make the Non-Structural Flood Demonstration Project attractive for riparian restoration. A complete irrigation infrastructure can be utilized for active restoration. The property is organized into agricultural fields that can be used in phasing restoration blocks. A current absence of significant exotic plant populations will ease native plant establishment. And finally, there is a potential for leveraging the on-site restoration activity by connecting with proposed Natural Resource Conservation Service easements. These easements, being negotiated with cooperating flood plan farmers, will be in the immediate area of refuge and will amplify the "block" effect of The Non-Structural Flood Demonstration Project

This report recommends active restoration as the preferred approach to the management of The Non-Structural Flood Demonstration Project. This active restoration would be scheduled for 1623 acres of the refuge. Active restoration is appropriate for those areas that have shown no natural recruitment, or where natural stands have started and failed. Active restoration can be patch tailored to avian species' needs and can produce habitat forests reliably with an established base for subsequent natural selection with fewer exotics. Active restoration works well with the vagaries of nature: flood, silt deposition, and, at the other extreme, drought. Also, by using farmer contractors in the restoration process, community participation and understanding of the restoration process can be achieved.

VIII. REFERENCES

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VIII. APPENDICES

A. Species Lists for Existing Vegetation

Common Species in Farm Fields:

Prickly lettuce	*Lactuca serriola*
Horseweed	*Conyza canadensis*
Silver horseweed (native)	*Conyza coulteri*
White sweet-clover	*Melilotus albus*
Sunflower	*Helianthus annuus*
Black mustard	*Brassica nigra*
Rip-gut brome grass	*Bromus diandrus*
Ox-tongue	*Picris echinoides*
Wide-leaved pepperweed	*Lepidium latifolium*
Sow thistle	*Sonchus olearceus*
Milk thistle	*Silybum marinum*

Species common on tops and sides of levees:

Wide-leaved pepperweed	*Lepidium latifolium*
Rip-gut brome grass	*Bromus diandrus*
Spikeweed (native)	*Hemizonia pungens*
Evening primrose (native)	*Oenothera hookeri*

Common and Frequent Species in Riparian Areas Adjacent to Restoration Fields:

Valley (black) willow	*Salix gooddingii*
Sandbar willow	*Salix exigua*
Fremont cottonwood	*Populus fremontii*
Buttonbush	*Cephalanthus occidentalis*
Oregon ash	*Fraxinus latifolia*
Box-elder	*Acer negundo*
Valley oak	*Quercus lobata*
Rose	*Rosa californica*
Mugwort	*Artemisia douglasiana*
Evening-primrose	*Oenothera hookeri*
Goldenrod	*Euthamia occidentalis*
California blackberry	*Rubus ursinus*
Basket-sedge	*Carex barbarae*
Creeping rye grass	*Leymus triticoides*

Common Species in Relict Meadow:

California loosestrife	*Lythrum californicum*
Marsh Baccharis (Baccharis douglasii)	
Mulefat	*Baccharis salicifolia*
Velvet willow-herb	*Epilobium sp.*
Hedge-nettle	*Stachys albens*
Marsh fleabane	*Pluchea odorata*
Creeping rush	*Juncus balticus*
Creeping rye grass	*Leymus triticoides*
Arroyo willow	*Salix lasiolepis*
Valley willow	*Salix gooddingii*
Sandbar willow	*Salix exigua*
Gum plant	*Grindelia camphorum var. camphorum*
Milkweed	*Asclepias fasciculatus*
Evening primrose	*Oenothera hookeri*
Spikeweed	*Hemizonia pungens*
Nettle	*Urtica dioica var. holosericea*

B. Species lists for proposed plant communities to be restored

Low Terrace and Lake edge: Buttonbush-Willow Scrub

Valley willow	*Salix gooddingii*
Buttonbush	*Cephalanthus occidentalis*
Oregon ash	*Fraxinus latifolia*
Fremont cottonwood	*Populus fremontii*
Basket-sedge	*Carex barbarae*
Creeping rye grass	*Leymus triticoides*
Marsh Baccharis	Baccharis douglasii
Indian hemp	*Apocynum cannabinum*
Creeping rush	*Juncus balticus*

Mid Terrace: Mixed Riparian Forest

Valley willow	*Salix gooddingii*
Oregon ash	*Fraxinus latifolia*
Fremont cottonwood	*Populus fremontii*
Box-elder	*Acer negundo*
Valley oak	*Quercus lobata*
Elderberry	*Sambucus mexicanus*
Rose	*Rosa californica*
California blackberry	*Rubus ursinus*
Basket-sedge	*Carex barbarae*
Creeping rye grass	*Leymus triticoides*
Sandbar willow	*Salix exigua*
Mulefat	*Baccharis salicifolia*
Arroyo willow	*Salix lasiolepis*

Upper Terrace: Valley Oak-Elderberry Riparian Forest

Valley oak	*Quercus lobata*
Elderberry	*Sambucus mexicanus*
Oregon ash	*Fraxinus latifolia*
Rose	*Rosa californica*
California blackberry	*Rubus ursinus*
Basket-sedge	*Carex barbarae*
Creeping rye grass	*Leymus triticoides*
Sandbar willow	*Salix exigua*
Mulefat	*Baccharis salicifolia*
Arroyo willow	*Salix lasiolepis*
Coyote brush	*Baccharis pilularis var. consanguinea*

For the following species, it is assumed that they will colonize the site during flood events:

Nettle	*Urtica dioica var. holosericea*
Mugwort	*Artemisia douglasiana*
Gum plant	*Grindelia camphorum*
Milkweed	*Asclepias fasciculatus*
Evening primrose	*Oenothera hookeri*
Goldenrod	*Euthamia occidentalis*
Spikeweed	*Hemizonia pungens*

C. Soil Pit Evaluations/Soil Type Descriptions

1. Soil Types

Please see the attached Preliminary Soil Survey of Stanislaus County for soil descriptions.

Clear Lake Clay rarely flooded (195 = number on NRCS soils map) – Delineates the beds of both upper and lower White Lakes. It extends continuously along the west edge of the property, virtually for its entire N-S length.
Columbia Complex, occasionally flooded (151)
Columbia Fine Sandy Loam frequently flooded (153)
Columbia Complex, rarely flooded (157)
Merritt Silty Clay occasionally flooded (160)
Merritt Silty Clay rarely flooded (165)
Dos Palos-Bolfar complex, occasionally flooded (170)
Dos Palos-Bolfar Complex, rarely flooded (175). Surrounds (upslope) the Lake beds
Dello Loamy Fine Sand frequently flooded (180) Floodplain channel
Capay Clay, wet, (101) se of Hospital Creek
Veritas Sandy Loam, rarely flooded (200)
Standing Water, (128)

2. Results of Soil Pit Excavations
(carried out by Tom Griggs and Victor Lyon – 13-14 October, 1999)

1. Hagemann Unit; Field 25, north end – alfalfa crop present.
   Mapped as DosPalos-Bolfar Complex –175 (NRCS mapping Number) (HAG 25, photograph label)

Profile:	0-3 ft	Gray fine sandy loam
	3 – 5.5 ft	Brown fine sand
	5.5 – 7 ft	Brown sand
	7 ft.	White hardpan

2. Hagemann Unit; Field 24, north edge, near unused canal, fallow field.
   Mapped as DosPalos-Bolfar Complex – 175 (HAG 24)

Profile:	0 – 2 ft.	Silty loam
	2 – 6 ft	Silty loam – damp
	6 – 8 ft	Loose sand – damp, mottles
	8 ft	Water

3. Hagemann Unit; Field 21, north edge, 100 ft from main drain (Lower White Lake)
   Mapped as DosPalos-Bolfar Complex –175 (HAG 21)

Profile:	Surface	Silt loam (with a small amount of sand)
	0 – 5 ft	Sandy loam
	5 – 6 ft	sandy loam with mottles
	6 ft	Water

4. Vierra Unit; 100 yards east of Dairy
   Mapped as Clear Lake Clay – 195 (VRA SW)

Profile:	Surface	Dry, hard, light gray clay
	0 – 2ft.	Blocky, gray clay with white inclusions; too hard, brittle to make ribbons
	2 –4.5ft	Brown clay with dark grey clay lenses; mottles
	4.5 ft.	Water

5. Vierra Unit: east of Dairy, east of central field-drain
Mapped as standing water - 128 (VRA 128)

Profile:	0 – 2 ft	Dark brown clay; soft, ribbons when damp.
	2 – 4 ft	Dark brown clay with orange mottles, forms ribbon
	4 – 6 ft	Gray clay, mottles; forms ribbon
	6 ft	Water

6. Vierra Unit; east of Dairy, 100 yards west of levee
Mapped as Merritt Silty Clay Loam – 165; (VRA 165)

Profile:	0 – 3.5 ft	Silty clay loam; dry; no or short ribbons when damp.
	3.5 – 8 ft	Silt-clay, damp; mottles
	8 ft.	Water

7. Vierra Unit; east of Levee, north end of volunteer willows (from 1997) these 10 ft tall.
Mapped as Columbia Complex – 151 (VRA 151)

Profile:	0 – 3 ft	Gray silt loam; dry
	3 – 6 ft	Red silt
	6 – 8 ft	Red silt, mottles, damp
	8 – 9 ft	Gray clayey silt, mottles, damp
	9 ft	Red silt, mottles, damp; white (living) roots present!
	10 ft	Red and gray silt, mottles, wet
		No free-standing water

8. Vierra Unit; 100 yards south of Hetch-Hetchy right of way.
Mapped as Merritt Silty Clay Loam – 160 (H-HS 160)

Profile:	0 – 3 ft	Light brown clayey silt, dry
	3 – 6 ft	Silt with orange and mostly black mottles
	6 – 11 ft	Clayey silt, orange mottles, damp; roots present!
	11 ft.	Water

9. Hagemann Unit; Field 25 – south end – alfalfa crop present
Mapped as DosPalos-Bolfar Complex – 175 (HAG 25 SOUTH)

Profile:	0 – 2 ft	Grayish-brown silty loam
	2 – 3.5 ft	Brown fine sandy loam
	3.5 – 4 ft	Brittle, white hardpan, fizzes in water, breaks into ¼ in blocks
	4 – 7 ft	Light brown very sandy loam
	7 – 12 ft	Light brown sand, very little moisture, no water in pit

10. Hagemann Unit; Field 22, near center, fallow field.
Mapped as Veritas Sandy Loam – 200 (HAG 22)

Profile:	0 – 2 ft	Grayish brown fine sandy loam
	2 – 4.5 ft	Yellowish-brown sandy loam: coarser and sandier than above
	4.5 – 6 ft	Light brown sand with <10% silt/clay, capillary zone
	6 – 9 ft	Damp. Pure light brown sand
	9 ft	Water table

11. Lara Unit; SSE of Barns and WSW of the relict meadow (pond) on NW corner of alfalfa field. Mapped as Columbia Complex – 157 (LARA CENTER PIT)

Profile:	0 – 2 ft	Brown sandy loam
	2 – 3 ft	Light brown sand
	3 – 4.5 ft	Gray silty clay with orange mottles, makes ribbon
	4.5 – 9 ft	Blocky, bluish-gray clay with white inclusions, resists water, difficult to make 2" ribbon as inclusions make the texture slightly grainy. Irrigation water seeping from top of clay layer.
	9 ft.	Water table

Natural Resources Conservation Service. 1999. Preliminary Soil Survey of Stanislaus County, Western Part, California. NRCS field office, Modesto, California.

Soil Descriptions

****100= Capay clay, 0 to 2 percent slopes

Setting
Landform: Interfan basins
Elevation: 40 to 250 feet
Slope features: Nearly level
Vegetation: Annual grasses and forbs
Mean annual precipitation: 10 to 12 inches
Mean annual temperature: 60 to 62 degrees F
Frost-free period: 260 to 280 days

Composition
***Capay clay and similar soils: about 90 percent
Dissimilar inclusions: 10 percent

Characteristics of the Capay Soil--
Parent material: Alluvium from sandstone and shale
Typical profile:

Surface layer
**0 to 20 inches= dark grayish brown clay
Subsoil
**20 to 60 inches= dark grayish brown and brown clay

Depth class: Very deep
Depth to bedrock: Greater than 60 inches
Drainage class: Moderately well drained
Water table: Greater than 6 feet
Available water capacity: High
Permeability: Slow
Intake family: 0.1
Surface runoff: Negligible to medium
Highest shrink swell potential: High
Hazard of flooding: None
Hazard of water erosion in bare areas: Slight
Corrosivity class: Steel= high; concrete= moderate

Minor components
Dissimilar inclusions
*Stomar soils on higher positions
*Vernalis soils on slightly higher positions
*Zacharias soils on higher positions
Similar inclusions
*Areas with a surface layer of silty clay or clay loam on similar positions

Use and management
Land use: Irrigated crops and homesite development

Irrigated crops
Commonly grown crops: Row, field and orchard crops
Major management factors: Fine surface texture, restricted permeability
*The soil is too sticky to cultivate when it is wet and is too hard to cultivate when it is dry
*The restricted permeability requires proper irrigation design with a low application rate and a longer application period to prevent stand deterioration
*Returning crop residue to the soil or regularly adding other organic matter improves fertility, reduces crusting and increases the water intake rate.
*Furrow, border and sprinkler irrigation systems are suited to this soil.

Homesite development
Major management factors: Shrink-swell, restricted permeability, low strength
*The effect of shrinking and swelling can be minimized by using proper engineering designs or backfilling material that has a low shrink-swell potential.
*Buildings and roads should be designed to offset the limited ability of the soil in this unit to support a load.
*The restricted permeability decreases the absorption capacity of the leach fields. Increasing the size of the leach field or using a specially designed system can overcome this limitation.

Interpretive groups
Capability: Unit IIs-5, irrigated; IVs-5, nonirrigated
MLRA: 17
Vegetative soil group: C

******101= Capay clay, wet, 0 to 2 percent slopes**
Setting
Landform: Interfan basins
Landscape features: As a result of the application of irrigation water on this unit, a apparent water table has developed at a depth of 2 to 4 feet.
Elevation: 30 to 200 feet
Slope features: Nearly level
Vegetation: Annual grasses and forbs
Mean annual precipitation: 10 to 12 inches
Mean annual temperature: 60 to 62 degrees F
Frost-free period: 260 to 280 days

Composition
***Capay clay and similar soils: about 85 percent
Dissimilar inclusions: 15 percent

Characteristics of the Capay Soil--
Parent material: Alluvium from sandstone and shale

Typical profile:

Surface layer
**0 to 20 inches= dark grayish brown clay
Subsoil

Soil Descriptions

**20 to 60 inches= dark grayish brown and brown clay

Depth class: Very deep
Depth to bedrock: Greater than 60 inches
Drainage class: Moderately well drained
Water table: 4 to 6 feet from the soil surface from January to December
Kind of water table: Apparent
Available water capacity: High
Permeability: Slow
Intake family: 0.1
Surface runoff: Negligible to medium
Highest shrink swell potential: High
Hazard of flooding: None
Hazard of water erosion in bare areas: Slight
Corrosivity class: Steel= high; concrete= moderate

Minor Components
Dissimilar inclusions
*Stomar soils on higher positions
*Vernalis soils on higher positions
Similar inclusions
*Areas with a surface layer of silty clay on similar positions
*Capay soils that lack an apparent water table on slightly higher positions

Use and management
Land use: Irrigated crops and homesite development

Irrigated crops
Commonly grown crops: Row, field and orchard crops
Major management factors: High water table, fine surface texture, restricted permeability
*High water table limits the suitability for deep rooted crops or can cause crop damage.
*Irrigation must be carefully managed to avoid raising the water table.
*Drainage systems that require continual maintenance have been used to lower the water table to a depth of 4 to 6 feet.
*Tile drainage can be used to lower the water table if a suitable outlet is available.
*The soil is too sticky to cultivate when it is wet and is too hard to cultivate when it is dry.
*The restricted permeability requires proper irrigation design with a low application rate and a longer application period to prevent stand deterioration.
*Returning crop residue to the soil or regularly adding other organic matter improves fertility, reduces crusting and increases the water intake rate.
*Furrow, border and sprinkler irrigation systems are suited to this soil.

Homesite development
Major management factors: High water table, shrink-swell, restricted permeability, low strength
*Do to the wetness of the soil profile in the winter and early spring months, a drainage system should be developed around the foundation.
*The effect of shrinking and swelling can be minimized by using proper engineering designs or backfilling material that has a low shrink-swell potential.
*Buildings and roads should be designed to offset the limited ability of the soil in this unit to support a load.
*When septic tanks are used, a high water table and restricted permeability decreases the absorption capacity of the leach field. A mounded leach field or other specialized leach field can overcome these limitations.

Interpretive groups
Capability: Unit IIw-5, irrigated; IVw-5, nonirrigated
MLRA: 17
Vegetative soil group: C

****102= Capay clay, loamy substratum, 0 to 2 percent slopes**

Setting
Landform: Interfan basins
Elevation: 25 to 175 feet
Slope features: Nearly level
Vegetation: Annual grasses and forbs
Mean annual precipitation: 10 to 12 inches
Mean annual temperature: 60 to 62 degrees F
Frost-free period: 260 to 280 days

Composition
***Capay clay, loamy substratum and similar soils: about 85 percent
Dissimilar inclusions: 15 percent

Characteristics of the Capay soil--
Parent material: Alluvium from sandstone and shale

Typical profile:
Surface layer
**0 to 20 inches= dark grayish brown clay
Subsoil
**20 to 35 inches= grayish brown clay
**35 to 45 inches= yellowish brown clay loam
Substratum
**45 to 60 inches= yellowish brown loam

Depth class: Very deep
Depth to bedrock: Greater than 60 inches

Soil Descriptions

texture, restricted permeability
*The soil is too sticky to cultivate when it is wet and is too hard to cultivate when it is dry.
*The restricted permeability requires proper irrigation design with a low application rate and a longer application period to prevent stand deterioration.
*Returning crop residue to the soil or regularly adding other organic matter improves fertility, reduces crusting and increases the water intake rate.
*Furrow, border and sprinkler irrigation systems are suited to this soil.

Homesite development
Major management factors: Shrink-swell, restricted permeability, low strength
*The effect of shrinking and swelling can be minimized by using proper engineering designs or backfilling material that has a low shrink-swell potential.
*Buildings and roads should be designed to offset the limited ability of the soil in this unit to support a load.
*The restricted permeability decreases the absorption capacity of the leach fields. Increasing the size of the leach field or using a specially designed system can overcome this limitation.

Interpretive groups
Capability: Unit IIs-3, irrigated: IVs-3, nonirrigated
MLRA: 17
Vegetative soil group: C

******111= El Solyo clay loam, wet, 0 to 2 percent slopes**

Setting
Landform: Low alluvial fans
Landscape features: As a result of the excessive application of water for irrigation, an apparent water table has developed at a depth of 2 to 4 feet.
Elevation: 40 to 200 feet
Slope features: Nearly level
Vegetation: Annual grasses and forbs
Mean annual precipitation: 10 to 12 inches
Mean annual temperature: 60 to 62 degrees F
Frost-free period: 260 to 280 days

Composition
***El Solyo clay loam and similar soils: about 85 percent
Dissimilar inclusions: 15 percent

Characteristics of the El Solyo soil--

Parent material: Alluvium from sedimentary and metamorphic rock sources

Typical profile:

Surface layer
*0 to 17 inches= pale brown clay loam
Subsoil
*17 to 60 inches= pale brown silty clay loam and light yellowish brown silty clay

Depth class: Very deep
Depth to bedrock: Greater than 60 inches
Drainage class: Well drained, but now is moderately well do to and apparent water table
Water table: 4 to 6 feet from the soil surface from December to March
Kind of water table: Apparent
Available water capacity: Very high
Permeability: Slow
Intake family: 0.5
Surface runoff: Negligible to medium
Highest shrink swell potential: High
Hazard of flooding: None
Hazard of water erosion in bare areas: Slight
Corrosivity class: Steel= high; concrete= low

Minor Components
Dissimilar inclusions
*Capay soils on lower positions
*Vernalis soils on similar positions
Similar inclusions
*Areas with a surface layer of silty clay on similar positions
*El Solyo soils that lack an apparent water table on higher positions

Use and management
Land use: Irrigated crops and homesite development

Irrigated crops
Commonly grown crops: Row, field and orchard crops
Major management factors: High water table, moderately fine surface texture, restricted permeability
*Irrigation must be carefully managed to avoid raising the water table.
*Deep rooted crops are suited to areas with natural drainage or where a drainage system has been installed.
*Drainage systems that require continual maintenance have been used to lower the water table to a depth of 4 to 6 feet.
*Tile drainage can be used to lower the water table if a suitable outlet is available.
*The soil is too sticky to cultivate when it is wet and

Soil Descriptions

is too hard to cultivate when it is dry.
*The restricted permeability requires proper irrigation design with a low application rate and a longer application period to prevent stand deterioration.
*Returning crop residue to the soil to regularly adding other organic matter improves fertility, reduces crusting and increases the water intake rate.
*Furrow, border and sprinkler irrigation systems are suited to this soil.

Homesite development
Major management factors: High water table, shrink-swell, restricted permeability, low strength
*Do to the wetness of the soil profile in the winter and early spring months, a drainage system should be developed around the foundation.
*The effect of shrinking and swelling can be minimized by using proper engineering designs or backfilling material that has a low shrink-swell potential.
*Buildings and roads should be designed to offset the limited ability of the soil in this unit to support a load.
*When septic tanks are used, a high water table and restricted permeability decreases the absorption capacity of the leach field. A mounded leach field or other specialized leach field can overcome these limitations.

Interpretive groups
Capability: Unit IIw-3, irrigated; IVw-3, nonirrigated
MLRA: 17
Vegetative soil group: C

******116= El Solyo silty clay loam, 0 to 2 percent slopes, rarely flooded**

Setting
Landform: Low alluvial fans
Elevation: 60 to 300 feet
Slope features: Nearly level
Vegetation: Annual grasses and forbs
Mean annual precipitation: 10 to 12 inches
Mean annual temperature: 60 to 62 degrees F
Frost-free period: 260 to 280 days

Composition
***El Solyo silty clay loam and similar soils: about 90 percent
Dissimilar inclusions: 10 percent

Characteristics of the El Solyo soil--
Parent material: Alluvium from sedimentary and metamorphic rock sources

Typical profile:

Surface layer
*0 to 17 inches= pale brown silty clay loam
Subsoil
*17 to 60 inches= pale brown silty clay loam and light yellowish brown silty clay

Depth class: Very deep
Depth to bedrock: Greater than 60 inches
Drainage class: Well drained
Water table: Greater than 6 feet
Available water capacity: Very high
Permeability: Slow
Intake family: 0.5
Surface runoff: Negligible to medium
Highest shrink swell potential: High
Hazard of flooding: Rare
Hazard of water erosion in bare areas: Slight
Corrosivity class: Steel= high; concrete= low

Minor Components
Dissimilar inclusions
*Vernalis soils on similar positions
*Zacharias soils on higher positions
Similar inclusions
*Areas with a surface layer of silty clay or clay loam on similar positions

Use and management
Land use: Irrigated crops and homesite development

Irrigated crops
Commonly grown crops: Row, field and orchard crops
Major management factors: Moderately fine textured surface, restricted permeability
*The soil is too sticky to cultivate when it is wet and is too hard to cultivate when it is dry.
*The restricted permeability requires proper irrigation design with a low application rate and a longer application period to prevent stand deterioration.
*Returning crop residue to the soil or regularly adding other organic matter improves fertility, reduces crusting and increases the water intake rate.
*Furrow, border and sprinkler irrigation systems are suited to this soil.

Homesite development
Major management factors: Flooding, shrink-swell, restricted permeability, low strength
*Flooding can occur during the winter and early spring months. The foundation should be taller than normal or the buildings located on the highest elevations. Water should be intercepted by

Soil Descriptions

****122 = Vernalis loam, 0 to 2 percent slopes

Setting
Landform: alluvial fans
Elevation: 25 to 300 feet
Slope features: nearly level
Vegetation: annual grasses and forbs
Mean annual precipitation: 10 to 12 inches
Mean annual temperature: 60 to 62 degrees F
Frost-free period: 260 to 280 days

Composition
***Vernalis loam and similar soils: about 85 percent
Dissimilar inclusions: 15 percent

Characteristics of the Vernalis soil--
Parent material: alluvium from mixed rock sources

Typical profile:

Surface layer
**0 to 20 inches= brown loam
Subsoil
**20 to 62 inches= yellowish brown and light yellowish brown clay loam

Depth class: very deep
Depth to bedrock: Greater than 5 feet
Drainage class: well drained
Depth to seasonal high water table: Greater than 6 feet
Available water capacity: high
Permeability: moderate
Intake family: 1.5
Surface runoff: negligible to low
Shrink swell potential: low
Hazard of flooding: none
Hazard of water erosion in bare areas: slight
Hazard of soil blowing in bare areas: slight
Corrosivity class: steel= high; concrete= low

Minor Components
Dissimilar inclusions
*Capay soils on concave positions
*Stomar soils on higher positions
*Zacharias soils on higher positions
Similar inclusions
*Areas with a surface layer of clay loam

Use and management
Land use: irrigated crops and homesite development

Irrigated crops
Commonly grown crops: row, field and orchard crops
Major management factors: None
* Furrow, border and sprinkler irrigation systems are suited to this soil.
* Returning crop residue to the soil or regularly adding other organic matter improves fertility, reduces crusting and maintains the water intake rate.

Homesite development
Major management factors: low strength
* Buildings and roads should be designed to offset the limited ability of the soil in this unit to support a load.

Interpretive groups
Capability unit: I, irrigated
Capability subclass: IVc-1, nonirrigated
MLRA: 17
Vegetative soil group: A

Form 5: CA0611

****123= Vernalis clay loam, wet, 0 to 2 percent slopes

Setting
Landform: Alluvial fans
Landscape features: As a result of the excessive application of water for irrigation, an apparent water table has developed at a depth of 2 to 4 feet.
Elevation: 25 to 300 feet
Slope features: Nearly level
Vegetation: Annual grasses and forbs
Mean annual precipitation: 10 to 12 inches
Mean annual temperature: 60 to 62 degrees F
Frost-free period: 260 to 280 days

Composition
***Vernalis clay loam and similar soils: about 85 percent
Dissimilar inclusions: 15 percent

Characteristics of the Vernalis soil--
Parent material: Alluvium from mixed rock sources

Typical profile:

Surface layer
**0 to 20 inches= brown clay loam
Subsoil
**20 to 62 inches= yellowish brown and light yellowish brown clay loam

Depth class: Very deep
Depth to bedrock: Greater than 60 inches

Soil Descriptions

Drainage class: Well drained, but is now moderately well do to an apparent water table
Water table: 4 to 6 feet from the soil surface from January through December
Kind of water table: Apparent
Available water capacity: High
Permeability: Moderately slow surface over moderate subsoil
Intake family: 0.7
Surface runoff: Negligible to low
Shrink swell potential: Moderate
Hazard of flooding: None
Hazard of water erosion in bare areas: Slight
Corrosivity class: Steel= high; concrete= low

Minor Components
Dissimilar inclusions
*Capay soils in concave positions
*Stomar soils on slightly higher positions
*Zacharias soils on slightly higher positions
Similar inclusions
*Areas with a surface layer of silty clay loam on similar positions

Use and management
Land use: Irrigated crops and homesite development

Irrigated crops
Commonly grown crops: Row, field, and orchard crops
Major management factors: High water table

*High water table limits the suitability for deep rooted crops or can cause crop damage.
*Deep rooted crops are suited to areas with natural drainage or where a drainage system has been installed.
*Drainage systems that require continual maintenance have been used to lower the water table to a depth of 4 to 6 feet.
*Tile drainage can be used to lower the water table if a suitable outlet is available.
*Furrow, border and sprinkler irrigation systems are suited to this soil.

Homesite development
Major management factors: High water table, restricted permeability, low strength
*Buildings and roads should be designed to offset the limited ability of the soil in this unit to support a load.
*When septic tanks are used, a high water table and restricted permeability decreases the absorption capacity of the leach field. A mounded leach field or other specialized leach field can overcome this limitation.

Interpretive groups
Capability: Unit IIw-2, irrigated; IVw-2, nonirrigated
MLRA: 17
Vegetative soil group: A

****125= Vernalis clay loam, 0 to 2 percent slopes

Setting
Landform: Alluvial fans
Elevation: 75 to 280 feet
Slope features: Nearly level
Vegetation: Annual grasses and forbs
Mean annual precipitation: 10 to 12 inches
Mean annual temperature: 60 to 62 degrees F
Frost-free period: 260 to 280 days

Composition
***Vernalis clay loam and similar soils: about 85 percent
Dissimilar inclusions: 15 percent

Characteristics of the Vernalis soil--
Parent material: Alluvium from mixed rock sources

Typical profile:

Surface layer
*0 to 20 inches= brown clay loam
Subsoil
*20 to 62 inches= yellowish brown and light yellowish brown clay loam

Depth class: Very deep
Depth to bedrock: Greater than 60 inches
Drainage class: Well drained
Depth to water table: Greater than 6 feet
Available water capacity: High
Permeability: Moderately slow surface over moderate subsoil
Intake family: 0.7
Surface runoff: Negligible to low
Highest shrink swell potential: Moderate
Hazard of flooding: None
Hazard of water erosion in bare areas: Slight
Corrosivity class: Steel= high; concrete= low

Inclusions
Dissimilar inclusions
*Capay soils in concave positions
*Stomar soils on slightly higher positions
*Zacharias soils on slightly higher positions
Similar inclusions

Soil Descriptions

Depth to bedrock: Greater than 60 inches
Drainage class: Well drained
Water table: Greater than 6 feet
Available water capacity: Moderate
Permeability: Moderately slow
Intake family: 0.5
Surface runoff: Negligible to low
Highest shrink swell potential: Moderate
Hazard of flooding: Rare
Hazard of water erosion in bare areas: Slight
Corrosivity class: Steel= high; concrete= low

Minor Components
Dissimilar inclusions
*Capay soils on concave positions
*Stomar soils on similar positions
*Vernalis soils on slightly lower positions
Similar inclusions
*Areas with a surface layer of clay loam on similar positions

Use and management
Land use: Irrigated crops, homesite development and livestock grazing

Irrigated crops
Commonly grown crops: Row, field and orchard crops
Major management factors: Surface rock fragments
*Surface rock fragments cause rapid wear of tillage equipment.
*Furrow, border and sprinkler irrigation systems are suited to this soil.

Homesite development
Major management factors: Flooding, restricted permeability, low strength
*Flooding can occur during the winter and early spring months. The foundation should be taller than normal or the buildings located on the highest elevations. Water should be intercepted by drainage ditches or a drainage system should be developed around the foundation.
*The restricted permeability decreases the absorption capacity of the leach fields. Increasing the size of the leach field or using a specially designed system can overcome this limitation.
*Buildings and roads should be designed to offset the limited ability of the soil in this unit to support a load.

Livestock grazing
Common plants on the Zacharias soil: Soft chess, filaree, wild oat, and red brome
Major management factors: Gravelly moderately fine surface texture
*Trampling by livestock can occur when the soil is too wet, which reduces productivity and increases runoff.

Interpretive groups
Capability: Subclass IIw-2, irrigated; IVw-2, nonirrigated
MLRA: 17
Ecological site: Fine-loamy
Vegetative soil group: A

******150= Columbia fine sandy loam, 0 to 2 percent slopes, occasionally flooded**

Setting
Landform: Floodplains
Landscape features: This unit is located in a designated floodway. Channeling and deposition are common along streambanks. Mottles in the profile indicate a somewhat poorly drained soil; however, drainage has now been improved by levees and reclamation projects.
Elevation: 25 to 50 feet
Slope features: Nearly level
Vegetation: Annual grasses and forbs
Mean annual precipitation: 10 to 12 inches
Mean annual temperature: 60 to 62 degrees F
Frost-free period: 260 to 280 days

Composition
***Columbia fine sandy loam and similar soils: about 85 percent
Dissimilar inclusions: 15 percent

Characteristics of the Columbia soil--
Parent material: Alluvium from mixed rock sources

Typical profile:

Surface layer
**0 to 14 inches= light brownish gray and pale brown fine sandy loam
Underlying material
**14 to 60 inches= brown and pale brown stratified sandy loam to fine sandy loam

Depth class: Very deep
Depth to bedrock: Greater than 60 inches
Drainage class: Somewhat poorly drained
Water table: 3 to 5 feet from the soil surface from December to April
Kind of water table: Apparent
Available water capacity: Moderate

Soil Descriptions

Permeability: Moderately rapid
Intake family: 1.5
Surface runoff: Negligible to very low
Highest shrink swell potential: Low
Hazard of flooding: Occasional, for brief to long periods from December through April
Hazard of water erosion in bare areas: Slight
Corrosivity class: Steel= moderate; concrete= low

Minor Components
Dissimilar inclusions
*Dello soils on similar positions
*Dospalos soils on similar positions
*Merritt soils on similar positions

Similar inclusions
*Areas with a surface layer of sandy loam on similar positions

Use and management
Land use: Current uses= irrigated crops; potential uses= homesite development

Irrigated crops
Commonly grown crops: Row and field crops
Major management factors: Flooding, high water table, lateral seepage
*Flooding and high water table limitations should be considered when planning stand renovation or reestablishment.
*Irrigation must be carefully managed to avoid raising the water table.
*Drainage systems that require continual maintenance have been used to lower the apparent water table to a depth of 3 to 5 feet.
*This unit is subject to lateral seepage in wet years when the water level is high.
*Tile drainage can be used to lower the water table if a suitable outlet is available.
*Furrow, border and sprinkler irrigation systems are suited to this soil.

Homesite development
Major management factors: Flooding, high water table
*Flooding and a high water table can occur during the winter and early spring months. The foundation should be taller than normal or the buildings located on the highest elevations. Water should be intercepted by drainage ditches or a drainage system should be developed around the foundation.
*When septic tanks are used, a high water table limits the absorption capacity of the leach field. A mounded leach field or other specialized leach field can overcome this limitation.
*Flooding can add additional water to the septic system. Diversion of flood waters reduces this limitation.

Interpretive groups
Capability: Unit IIw-2, irrigated; IVw-2, nonirrigated
MLRA: 17
Vegetative soil group: E

******151= Columbia complex, 0 to 2 percent slopes, occasionally flooded**

Setting
Landform: Floodplains
Landscape features: This unit is located in a designated floodway. Mottles in the profile indicate a somewhat poorly drained soil; however, drainage has now been improved by levees and reclamation projects.
Slope features: Nearly level
Elevation: 25 to 50 feet
Vegetation: Annual grasses and forbs
Mean annual precipitation: 10 to 12 inches
Mean annual temperature: 60 to 62 degrees F
Frost-free period: 260 to 280 days

Composition
***Columbia fine sandy loam and similar soils: about 45 percent
***Columbia fine sandy loam, sandy substratum and similar soils: about 40 percent
Dissimilar inclusions: 15 percent

Characteristics of the Columbia fine sandy loam soil--
Parent material: Alluvium from mixed rock sources

Typical profile:
Surface layer
*0 to 14 inches= light brownish gray and pale brown fine sandy loam
Underlying material
*14 to 60 inches= brown and pale brown stratified sandy loam and fine sandy loam

Depth class: Very deep
Depth to bedrock: Greater than 60 inches
Drainage class: Somewhat poorly drained
Water table: 3 to 5 feet from the soil surface from December to April
Kind of water table: Apparent
Available water capacity: Moderate
Permeability: Moderately rapid
Intake family: 1.5
Surface runoff: Negligible to very low

Soil Descriptions

Highest shrink swell potential: Low
Hazard of flooding: Occasional, for brief to long periods, from December through April
Hazard of water erosion in bare areas: Slight
Corrosivity class: Steel= moderate; concrete= low

Characteristics of the Columbia fine sandy loam, sandy substratum part--
Parent material: Alluvium from mixed rock sources

Typical profile:

Surface layer
*0 to 12 inches= mottled brown and pale brown fine sandy loam
Underlying material
*12 to 41 inches= mottled brown and pale brown sandy loam
*41 to 60 inches= mottled light gray stratified loamy sand and sand

Depth class: Very deep
Depth to bedrock: Greater than 60 inches
Drainage class: Somewhat poorly drained
Water table: 3 to 5 feet from the soil surface from December to April
Kind of water table: Apparent
Available water capacity: Moderate
Permeability: Moderately rapid subsoil and rapid sandy substratum
Intake family: 1.5
Surface runoff: Negligible to low
Highest shrink swell potential: Low
Hazard of flooding: Occasional, for brief to long periods, from December through April
Hazard of water erosion in bare areas: Slight
Corrosivity class: Steel= moderate; concrete= low

Minor Components
Dissimilar inclusions
*Dello soils on similar positions
*Dospalos soils on similar positions
*Merritt soils on similar positions
Similar inclusions
*Areas with a surface layer of sandy loam on similar positions

Use and management
Land use: Current use= irrigated crops; potential use= homesite development

Irrigated crops
Commonly grown crops: Row and field crops
Major management factors: Columbia= flooding, high water table, lateral seepage; Columbia, sandy substratum= flooding, high water table, lateral seepage, coarse textured underlying material
*Flooding and high water table limitations should be considered when planning stand renovation or reestablishment.
*Irrigation must be carefully managed to avoid raising the water table.
*Drainage systems that require continual maintenance have been used to lower the apparent water table to a depth of 3 to 5 feet.
*This unit is subject to lateral seepage in wet years when the water level is high.
*Tile drainage can be used to lower the water table if a suitable outlet is available.
*Water should be applied in amounts sufficient to wet the root zone but in amounts small enough to minimize the leaching of plant nutrients.
*Furrow, border and sprinkler irrigation systems are suited to this soil.

Homesite development
Major management factors: Columbia= flooding, high water table; Columbia, sandy substratum= flooding, high water table, poor filter
*Flooding and a high water table can occur during the winter and early spring months. The foundation should be taller than normal or the buildings located on the highest elevations. Water should be intercepted by drainage ditches or a drainage system should be developed around the foundation.
*When septic tanks are used, a high water table limits the absorption capacity of the leach field. A mounded leach field or other specialized leach field can overcome this limitation.
*Flooding can add additional water to the septic system. Diversion of flood waters reduces this limitation.
*The coarse texture of the underlying material limits filtering capacity. Inadequately filtered effluent can contaminate the surface or ground water. Special designs can overcome this limitation.
*As the density of homesites increase, a community disposal system should be considered.

Interpretive groups
Capability: Columbia= unit IIw-2, irrigated; IVw-2, nonirrigated; Columbia, sandy substratum= unit IIIw-0, irrigated; IVw-0, nonirrigated
MLRA: 17
Vegetative soil group: Columbia= E; Columbia, sandy substratum= B

Soil Descriptions

****153= Columbia fine sandy loam, channeled, 0 to 2 percent slopes, frequently flooded

Setting
Landform: Floodplains
Elevation: 25 to 50 feet
Landscape features: This unit is located in a designated floodway and is not protected by any levee system. Channeling and deposition are common along streambanks. Mottles in the profile indicate a somewhat poorly drained soil; however, drainage has now been improved by reclamation projects.
Slope features: Nearly level channeled with numerous intermittent drainageways
Vegetation: Annual grasses, forbs and hydrophytic vegetation
Mean annual precipitation: 10 to 12 inches
Mean annual temperature: 60 to 62 degrees F
Frost-free period: 260 to 280 days

Composition
***Columbia fine sandy loam and similar soils: about 85 percent
Dissimilar inclusions: 15 percent

Characteristics of the Columbia soil--
Parent material: Alluvium from mixed rock sources

Typical profile:

Surface layer
**0 to 14 inches= light brownish gray and pale brown fine sandy loam
Underlying material
**14 to 60 inches= brown and pale brown stratified fine sandy loam and sandy loam

Depth class: Very deep
Depth to bedrock: Greater than 60 inches
Drainage class: Somewhat poorly drained
Water table: 3 to 5 feet from the soil surface from December to April
Kind of water table: Apparent
Available water capacity: Moderate
Permeability: Moderately rapid
Intake family: 1.5
Surface runoff: Negligible to very low
Highest shrink swell potential: Low
Hazard of Flooding: Frequent, for brief to long periods, from December through April
Hazard of water erosion in bare areas: Slight
Corrosivity class: Steel= moderate; concrete= low

Minor Components

Dissimilar inclusions
*Dello soils on similar positions
*Dospalos soils on similar positions
*Merritt soils on similar positions
Similar inclusions
*Areas with a surface layer of sandy loam on similar positions

Use and management
Land use: Current use= wildlife habitat; potential uses=irrigated crops

Wildlife habitat
Major management factors: Few limitations

Irrigated crops
Commonly grown crops: Row and field crops
Major management factors: Channeled landscape, flooding, high water table, lateral seepage
*Land leveling the channeled landscape may require deep cuts that will expose highly variable stratified substrata.
*Flooding and high water table limitations should be considered when planning stand renovation or reestablishment.
*Irrigation must be carefully managed to avoid raising the water table.
*Drainage systems that require continual maintenance have been used to lower the apparent water table to a depth of 3 to 5 feet.
*This unit is subject to lateral seepage in wet years when the water level is high.
*Tile drainage can be used to lower the water table if a suitable outlet is available.
*Furrow, border and sprinkler irrigation systems are suited to this soil.

Interpretive groups
Capability: Unit IVw-2, irrigated; IVw-2, nonirrigated
MLRA: 17
Vegetative soil group: E

******155= Columbia fine sandy loam, 0 to 2 percent slopes, rarely flooded**

Setting
Landform: Floodplains
Elevation: 25 to 50 feet
Landscape features: The construction of a system of levees and large upstream dams has reduced the hazard of flooding. Mottles in the profile indicate a somewhat poorly drained soil; however, drainage has now been improved by levees and reclamation projects.

Soil Descriptions

Slope features: Nearly level
Vegetation: Annual grasses and forbs
Mean annual precipitation: 10 to 12 inches
Mean annual temperature: 60 to 62 degrees F
Frost-free period: 260 to 280 days

Composition
***Columbia fine sandy loam and similar soils: about 85 percent
Dissimilar inclusions: 15 percent

Characteristics of the Columbia soil--
Parent material: Alluvium from mixed rock sources

Typical profile:

Surface layer
**0 to 14 inches= light brown and pale brown fine sandy loam
Underlying material
**14 to 60 inches= brown and pale brown stratified sandy loam to fine sandy loam

Depth class: Very deep
Depth to bedrock: Greater than 60 inches
Drainage class: Somewhat poorly drained
Water table: 3 to 5 feet from the soil surface from December to April
Kind of water table: Apparent
Permeability: Moderately rapid
Available water capacity: Moderate
Intake family: 1.5
Surface runoff: Negligible to very low
Highest shrink swell potential: Low
Hazard of flooding: Rare
Hazard of water erosion in bare areas: Slight
Corrosivity class: Steel= moderate; concrete= low

Minor Components
Dissimilar inclusions
*Dello soils on similar positions
*Dospalos soils on similar positions
*Merritt soils on similar positions
Similar inclusions
*Areas with a surface layer of sandy loam on similar positions

Use and management
Land use: Irrigated crops and homesite development

Irrigated crops
Commonly grown crops: Row and field crops
Major management factors: Flooding, high water table, lateral seepage
*Flooding and high water table limitations should be considered when planning stand renovation or reestablishment.
*Irrigation must be carefully managed to avoid raising the water table.
*Drainage systems that require continual maintenance have been used to lower the apparent water table to a depth of 3 to 5 feet.
*This unit is subject to lateral seepage in wet years when the water level is high.
*Tile drainage can be used to lower the water table if a suitable outlet is available.
*Furrow, border and sprinkler irrigation systems are suited to this soil.

Homesite development
Major management factors: Flooding, high water table
*Flooding and a high water table can occur during the winter and early spring months. The foundation should be taller than normal or the buildings located on the highest elevations. Water should be intercepted by drainage ditches or a drainage system should be developed around the foundation.
*When septic tanks are used, a high water table limits the absorption capacity of the leach field. A mounded leach field or other specialized leach field can overcome this limitation.
*Flooding can add additional water to the septic system. Diversion of flood waters reduces this limitation.

Interpretive Groups
Capability: Columbia= unit IIw-2, irrigated; IVw-2, nonirrigated
MLRA: 17
Vegetative soil group: E

******157= Columbia complex, 0 to 2 percent slopes, rarely flooded**

Setting
Landform: Floodplains
Elevation: 25 to 50 feet
Landscape features: The construction of a system of levees and large upstream dams has reduced the hazard of flooding. Mottles in the profile indicate a somewhat poorly drained soil; however, drainage has now been improved by levees and reclamation projects.
Slope features: Nearly level
Vegetation: Annual grasses and forbs
Mean annual precipitation: 10 to 12 inches
Mean annual temperature: 60 to 62 degrees F
Frost-free period: 260 to 280 days

Soil Descriptions

Composition
***Columbia fine sandy loam and similar soils: about 45 percent
***Columbia fine sandy loam, sandy substratum and similar soils: about 40 percent
Dissimilar inclusions: 15 percent

Characteristics of the Columbia soil--
Parent material: Alluvium from mixed rock sources

Typical profile:

Surface layer
**0 to 14 inches= light brown and pale brown fine sandy loam
Underlying material
**14 to 60 inches= brown and pale brown stratified sandy loam to fine sandy loam

Depth class: Very deep
Depth to bedrock: Greater than 60 inches
Drainage class: Somewhat poorly drained
Water table: 3 to 5 feet from the soil surface from December to April
Kind of water table: Apparent
Available water capacity: Moderate
Permeability: Moderately rapid
Intake family: 1.5
Surface runoff: Negligible to very low
Highest shrink swell potential: Low
Hazard of flooding: Rare
Hazard of water erosion in bare areas: Slight
Corrosivity class: Steel= moderate: concrete= low

Characteristics of the Columbia, sandy substratum soil--
Parent material: Alluvium from mixed rock sources

Typical profile:

Surface layer
**0 to 12 inches= brown and pale brown fine sandy loam
Underlying material
**12 to 41 inches= brown and pale brown sandy loam
**41 to 60 inches= light gray stratified loamy sand and sand

Depth class: Very deep
Depth to bedrock: Greater than 60 inches
Drainage class: Somewhat poorly drained
Water table: 3 to 5 feet from the soil surface from December to April
Kind of water table: Apparent
Available water capacity: Moderate
Permeability: Moderately rapid subsoil and rapid sandy substratum
Intake family: 1.5
Surface runoff: Negligible to very low
Highest shrink swell potential: Low
Hazard of flooding: Rare
Hazard of water erosion in bare areas: Slight
Corrosivity class: Steel= moderate: concrete= low

Minor Components
Dissimilar inclusions
*Dello soils on similar positions
*Dospalos soils on similar positions
*Merritt soils on similar positions
Similar inclusions
*Areas with a surface layer of sandy loam on similar positions

Use and management
Land use: Irrigated crops and homesite development

Irrigated crops
Commonly grown crops: Row and field crops
Major management factors: Columbia= flooding, high water table, lateral seepage: Columbia, sandy substratum= flooding, high water table, lateral seepage, coarse textured underlying material
*Flooding and high water table limitations should be considered when planning stand renovation or reestablishment.
*Irrigation must be carefully managed to avoid raising the water table.
*Drainage systems that require continual maintenance have been used to lower the apparent water table to a depth of 3 to 5 feet.
*This unit is subject to lateral seepage in wet years when the water level is high.
*Tile drainage can be used to lower the water table if a suitable outlet is available.
*Water should be applied in amounts sufficient to wet the root zone but in amounts small enough to minimize the leaching of plant nutrients.
*Furrow, border and sprinkler irrigation systems are suited to this soil.

Homesite development
Major management factors: Columbia= flooding, high water table: Columbia, sandy substratum= flooding, high water table, poor filter
*Flooding and a high water table can occur during the winter and early spring months. The foundation should be taller than normal or the buildings located on the highest elevations. Water should

Soil Descriptions

be intercepted by drainage ditches or a drainage system should be developed around the foundation.
*When septic tanks are used, a high water table limits the absorption capacity of the leach field. A mounded leach field or other specialized leach field can overcome this limitation.
*Flooding can add additional water to the septic system. Diversion of flood waters reduces this limitation.
*The coarse texture of the underlying material limits filtering capacity. Inadequately filtered effluent can contaminate the surface or ground water. Special designs can overcome this limitation.
*As the density of homesites increase, a community disposal system should be considered.

Interpretive groups
Capability: Columbia= unit IIw-2, irrigated; IVw-2, nonirrigated; Columbia, sandy substratum= IIIw-0, irrigated; IVw-0, nonirrigated
MLRA: 17
Vegetative soil group: Columbia= E; Columbia, sandy substratum= B

*****159= Columbia complex, 0 to 2 percent slopes, frequently flooded**

Setting
Landform: Floodplains
Elevation: 25 to 50 feet
Landscape features: This unit is located in a designated floodway and is not protected by any levee system. Mottles in the profile indicate a somewhat poorly drained soil; however, drainage has now been improved by reclamation projects.
Slope features: Nearly level
Vegetation: Annual grasses and forbs
Mean annual precipitation: 10 to 12 inches
Mean annual temperature: 60 to 62 degrees F
Frost-free period: 260 to 280 days

Composition
***Columbia fine sandy loam and similar soils: about 45 percent
***Columbia fine sandy loam, sandy substratum and similar soils: about 40 percent
Dissimilar inclusions: 15 percent

Characteristics of the Columbia soil--
Parent material: Alluvium from mixed rock sources
Typical profile:
Surface layer
**0 to 14 inches= light brown and pale brown fine sandy loam
Underlying material
**14 to 60 inches= brown and pale brown sandy loam and fine sandy loam

Depth class: Very deep
Depth to bedrock: Greater than 60 inches
Drainage class: Somewhat poorly drained
Water table: 3 to 5 feet from the soil surface from December to April
Kind of water table: Apparent
Available water capacity: Moderate
Permeability: Moderately rapid
Intake family: 1.5
Surface runoff: Negligible to very low
Highest shrink swell potential: Low
Hazard of flooding: Frequent, for brief to long periods, from December through April
Hazard of water erosion in bare areas: Slight
Corrosivity class: Steel= moderate; concrete= low

Characteristics of the Columbia, sandy substratum soil--
Parent material: Alluvium from mixed rock sources

Typical profile:

Surface layer
**0 to 12 inches= mottled brown and pale brown fine sandy loam
Underlying material
**12 to 41 inches= mottled brown and pale brown sandy loam
**41 to 60 inches= mottled light gray stratified loamy sand and sand

Depth class: Very deep
Depth to bedrock: Greater than 60 inches
Drainage class: Somewhat poorly drained
Water table: 3 to 5 feet from the soil surface from December to April
Kind of water table: Apparent
Available water capacity: Moderate
Permeability: Moderately rapid subsoil and rapid sandy substratum
Intake family: 1.5
Surface runoff: Negligible to very low
Highest shrink swell potential: Low
Hazard of flooding: Frequent, for brief to long periods, from December through April
Hazard of water erosion in bare areas: Slight
Corrosivity class: Steel= moderate; concrete= low

Minor Components

Soil Descriptions

Dissimilar inclusions
*Dello soils on similar positions
*Dospalos soils on similar positions
*Merritt soils on similar positions
*Moderately coarse textured stratified soils with apparent water tables within 3 feet of the surface on similar positions
Similar inclusions
*Areas with a surface layer of sandy loam on similar positions

Use and management
Land use: Irrigated crops

Irrigated crops
Commonly grown crops: row and field crops
Major management factors: Columbia= flooding, high water table, lateral seepage: Columbia, sandy substratum= flooding, high water table, lateral seepage, coarse textured underlying material
*Flooding and high water table limitations should be considered when planning stand renovation or reestablishment.
*Irrigation must be carefully managed to avoid raising the water table.
*This unit is subject to lateral seepage in wet years when the water level is high.
*Tile drainage can be used to lower the water table if a suitable outlet is available.
*Water should be applied in amounts sufficient to wet the root zone but in amounts small enough to minimize the leaching of plant nutrients.
*Furrow, border and sprinkler irrigation systems are suited to this soil.

Interpretive groups
Capability: Columbia= unit IIw-2, irrigated; IVw-2, nonirrigated; Columbia, sandy substratum= unit IIIw-0, irrigated; IVw-0, nonirrigated
MLRA: 17
Vegetative soil group: Columbia= E; Columbia, sandy substratum= B

******160= Merritt silty clay loam, 0 to 2 percent slopes, occasionally flooded**

Setting
Landform: Floodplains
Elevation: 25 to 50 feet
Landscape features: This unit is located in a designated floodway. Channeling and deposition are common along streambanks. Mottles in the profile indicate a poorly drained soil; however, drainage has now been improved by levees and reclamation projects.
Slope features: Nearly level
Vegetation: Annual grasses and forbs
Mean annual precipitation: 10 to 12 inches
Mean annual temperature: 60 to 62 degrees F
Frost-free period: 260 to 280 days

Composition
***Merritt silty clay loam and similar soils: about 85 percent
Dissimilar inclusions: 15 percent

Characteristics of the Merritt soil--
Parent material: Alluvium from sedimentary rock sources

Typical profile:

Surface layer
**0 to 12 inches= dark gray silty clay loam
Subsoil
**12 to 38 inches= dark grayish brown silt loam
Underlying material
**38 to 60 inches= light brownish gray stratified loamy fine sand to silt loam

Depth class: Very deep
Depth to bedrock: Greater than 60 inches
Drainage class: Poorly drained
Water table: 4 to 6 feet below the soil surface from December through April
Kind of water table: Apparent
Available water capacity: High
Permeability: Moderately slow
Intake family: 0.3
Surface runoff: Negligible to medium
Highest shrink swell potential: Moderate
Hazard of flooding: Occasional, for brief to long periods, from December through April
Hazard of water erosion in bare areas: Slight
Corrosivity class: Steel= high; concrete= low

Minor Components
Dissimilar inclusions
*Columbia soils on similar positions
*Dello soils on similar positions
*Dospalos soils on similar positions
Similar inclusions
*Areas with a surface layer of silt loam or fine sandy loam on similar positions

Use and management
Land use: Irrigated crops and homesite development

Irrigated crops

Soil Descriptions

Commonly grown crops: row, field and orchard crops
Major management factors: Flooding, high water table, lateral seepage
*Flooding and high water table limitations should be considered when planning stand renovation or reestablishment
*Irrigation must be carefully managed to avoid raising the water table.
*Drainage systems that require continual maintenance have been used to lower the apparent water table to a depth of 4 to 6 feet.
*Tile drainage can be used to lower the water table if a suitable outlet is available.
*Areas adjacent to levees are subject to lateral seepage in wet years when the water level is high.
*Furrow, border and sprinkler irrigation systems are suited to this soil.

Homesite development
Major management factors: Flooding, high water table
*Flooding and a high water table can occur during the winter and early spring months. The foundation should be taller than normal or the buildings located on the highest elevations. Water should be intercepted by drainage ditches or a drainage system should be developed around the foundation.
*When septic tanks are used, a high water table limits the absorption capacity of the leach field. A mounded leach field or other specialized leach field can overcome this limitation.
*Flooding can add additional water to the septic system. Diversion of flood waters reduces this limitation.

Interpretive groups
Capability: Unit IIw-2, irrigated; IVw-2, nonirrigated
MLRA: 17
Vegetative soil group: E

******165= Merritt silty clay loam, 0 to 2 percent slopes, rarely flooded**

Setting
Landform: Floodplains
Elevation: 25 to 50 feet
Landscape features: The construction of a system of levees and large upstream dams has reduced the hazard of flooding. Mottles in the profile indicate a poorly drained soil; however, drainage has now been improved by levees and reclamation projects.
Slope features: Nearly level
Vegetation: Annual grasses and forbs
Mean annual precipitation: 10 to 12 inches
Mean annual temperature: 60 to 62 degrees F
Frost-free period: 260 to 280 days

Composition
***Merritt silty clay loam and similar soils: about 85 percent
Dissimilar inclusions: 15 percent

Characteristics of the Merritt soil
Parent material: Alluvium from sedimentary rock sources

Typical profile:

Surface layer
*0 to 12 inches= grayish brown silty clay loam
Subsoil
*12 to 38 inches= dark brownish gray and grayish brown silty clay loam
Underlying material
*38 to 60 inches= grayish brown stratified fine sandy loam and sandy loam

Depth class: Very deep
Depth to bedrock: Greater than 60 inches
Drainage class: Poorly drained
Water table: 4 to 6 feet below the soil surface from December through April
Kind of water table: Apparent
Available water capacity: High
Permeability: Moderately slow
Intake family: 0.3
Surface runoff: Negligible to medium
Highest shrink swell potential: Moderate
Hazard of flooding: Rare
Hazard of water erosion in bare areas: Slight
Corrosivity class: Steel= high; concrete= low

Minor Components
Dissimilar inclusions
*Columbia soils on similar positions
*Dello soils on similar positions
*Dospalos soils on similar positions
Similar inclusions
*Areas with a surface layer of silt loam or clay loam on similar positions

Use and management
Land use: Irrigated crops and homesite development

Irrigated crops
Commonly grown crops: row, field and orchard crops
Major management factors: Flooding, high water table, lateral seepage
*Flooding and high water table limitations should be

Soil Descriptions

considered when planning stand renovation or reestablishment
*Irrigation must be carefully managed to avoid raising the water table.
*Drainage systems that require continual maintenance have been used to lower the apparent water table to a depth of 4 to 6 feet.
*Tile drainage can be used to lower the water table if a suitable outlet is available.
*Areas adjacent to levees are subject to lateral seepage in wet years when the water level is high.
*Furrow, border and sprinkler irrigation systems are suited to this soil.

Homesite development
Major management factors: Flooding, high water table
*Flooding and a high water table can occur during the winter and early spring months. The foundation should be taller than normal or the buildings located on the highest elevations. Water should be intercepted by drainage ditches or a drainage system should be developed around the foundation.
*When septic tanks are used, a high water table limits the absorption capacity of the leach field. A mounded leach field or other specialized leach field can overcome this limitation.
*Flooding can add additional water to the septic system. Diversion of flood waters reduces this limitation.

Interpretive groups
Capability: Unit IIw-2, irrigated; IVw-2, nonirrigated
MLRA: I7
Vegetative soil group: E

******170= Dospalos-Bolfar complex, 0 to 2 percent slopes, occasionally flooded**

Setting
Landform: Floodplains
Elevation: 35 to 60 feet
Landscape features: This unit is located in a designated floodway. Mottles in the profile indicate a poorly drained soil; however, drainage has now been improved by levees and reclamation projects.
Slope features: Nearly level
Vegetation: Annual grasses and forbs
Mean annual precipitation: 10 to 12 inches
Mean annual temperature: 60 to 62 degrees F
Frost-free period: 260 to 280 days

Composition
***Dospalos clay and similar soils: about 45 percent
***Bolfar clay loam and similar soils: about 40 percent
Dissimilar inclusions: 15 percent

Characteristics of the Dospalos soil--
Parent material: Alluvium dominantly from granitic rock sources

Typical profile:
Surface layer
**0 to 26 inches= olive gray and grayish brown clay
Subsoil
**26 to 44 inches= mottled grayish brown clay loam
Underlying material
**44 to 60 inches= light brownish gray clay loam

Depth class: Very deep
Depth to bedrock: Greater than 60 inches
Drainage class: Poorly drained
Water table: 3 to 5 feet from the soil surface from December through April
Kind of water table: Apparent
Available water capacity: Moderate
Permeability: Slow
Intake family: 0.5
Surface runoff: Negligible to medium
Highest shrink swell potential: High
Hazard of flooding: Occasional, for brief to long periods, from December through April
Hazard of water erosion in bare areas: Slight
Corrosivity class: Steel= high; concrete= moderate

Characteristics of the Bolfar soil--
Parent material: Alluvium dominantly from granitic rock sources

Typical profile:

Surface layer
**0 to 24 inches= mottled grayish brown and dark grayish brown clay loam
Subsoil
**24 to 38 inches= mottled light brownish gray and grayish brown loam
Underlying material
**38 to 60 inches= stratified pale brown loam and sandy loam

Depth class: Very deep
Depth to bedrock: Greater than 60 inches
Drainage class: Poorly drained
Water table: 3 to 5 feet from the soil surface, from December through April
Kind of water table: Apparent
Available water capacity: Moderate

Soil Descriptions

Permeability: Moderately slow
Intake family: 1.0
Surface runoff: Negligible to low
Highest shrink swell potential: Moderate
Hazard of flooding: Occasional, for brief to long periods, from December through April
Hazard of water erosion in bare areas: Slight
Corrosivity class: Steel= high; concrete= low

Minor Components
Dissimilar inclusions
*Clear Lake soils in concave positions
*Columbia soils on similar positions
*Dello soils on similar positions
*Merritt soils on similar positions
Similar inclusions
*Areas with a surface layer of silty clay loam or clay on similar positions

Use and management
Land use: Irrigated crops and homesite development

Irrigated crops
Commonly grown crops: row and field crops
Major management factors: Dospalos= flooding, high water table, fine surface texture, restricted permeability; Bolfar= flooding, high water table, lateral seepage
*Flooding and high water table limitations should be considered when planning stand renovation or reestablishment
*Irrigation must be carefully managed to avoid raising the water table.
*Drainage systems that require continual maintenance have been used to lower the apparent water table to a depth of 3.5 to 5 feet.
*Tile drainage can be used to lower the water table if a suitable outlet is available.
*Areas adjacent to levees are subject to lateral seepage in wet years when the water level is high.
*The soil is too sticky to cultivate when it is wet and is too hard to cultivate when it is dry.
*The restricted permeability requires proper irrigation design with a low application rate and a longer application period to prevent stand deterioration.
*Returning crop residue to the soil or regularly adding other organic matter improves fertility, reduces crusting and increases the water intake rate.
*Furrow, border and sprinkler irrigation systems are suited to this soil.

Homesite development
Major management factors: Dospalos= flooding, high water table, shrink-swell, restricted permeability, low strength; Bolfar= flooding, high water table, restricted permeability, low strength
*Flooding and a high water table can occur during the winter and early spring months. The foundation should be taller than normal or the buildings located on the highest elevations. Water should be intercepted by drainage ditches or a drainage system should be developed around the foundation.
*The effect of shrinking and swelling can be minimized by using proper engineering designs or backfilling material that has a low shrink-swell potential.
*Buildings and roads should be designed to offset the limited ability of the soil in this unit to support a load.
*When septic tanks are used, a high water table and restricted permeability decreases the absorption capacity of the leach field. A mounded leach field or other specialized leach field can overcome this limitation.
*Flooding can add additional water to the septic system. Diversion of flood waters reduces this limitation.

Interpretive groups
Capability: For both components= unit IIw-3, irrigated; IVw-3, nonirrigated
MLRA: 17
Vegetative soil group: For both components= E

******175= Dospalos-Bolfar complex, 0 to 2 percent slopes, rarely flooded**

Setting
Landform: Floodplains
Elevation: 35 to 60 feet
Landscape features: The construction of a system of levees and large upstream dams has reduced the hazard of flooding. Mottles in the profile indicate a poorly drained soil; however, drainage has now been improved by levees and reclamation projects.
Slope features: Nearly level
Vegetation: Annual grasses and forbs
Mean annual precipitation: 10 to 12 inches
Mean annual temperature: 60 to 62 degrees F
Frost-free period: 260 to 280 days

Composition
***Dospalos clay and similar soils: about 45 percent
***Bolfar clay loam and similar soils: about 45 percent
Dissimilar inclusions: 10 percent

Characteristics of the Dospalos soil--
Parent material: Alluvium dominantly from granitic rock

Soil Descriptions

sources

Typical profile:
Surface layer
**0 to 26 inches= olive gray and grayish brown clay
Subsoil
**26 to 44 inches= mottled grayish brown clay loam
Underlying material
**44 to 60 inches= light brownish gray clay loam

Depth class: Very deep
Depth to bedrock: Greater than 60 inches
Drainage class: Poorly drained
Water table: 3 to 5 feet from the soil surface from December to April
Kind of water table: Apparent
Available water capacity: Moderate
Permeability: Slow
Intake family: 0.1
Surface runoff: Negligible to medium
Highest shrink swell potential: High
Hazard of flooding: Rare
Hazard of water erosion in bare areas: Slight
Corrosivity class: Steel= high; concrete= moderate

Characteristics of the Bolfar soil--
Parent material: Alluvium dominantly from granitic rock sources

Typical profile:

Surface layer
**0 to 24 inches= mottled grayish brown and dark grayish brown clay loam
Subsoil
**24 to 38 inches= mottled light brownish gray and grayish brown loam
Underlying material
**38 to 60 inches= stratified pale brown loam and sandy loam

Depth class: Very deep
Depth to bedrock: Greater than 60 inches
Drainage class: Poorly drained
Water table: 3 to 5 feet from the soil surface from December to April
Kind of water table: Apparent
Available water capacity: High
Permeability: Moderately slow
Intake family: 1.0
Surface runoff: Negligible to low
Highest shrink swell potential: Moderate
Hazard of flooding: Rare
Hazard of water erosion in bare areas: Slight
Corrosivity class: Steel= high; concrete= low

Minor Components
Dissimilar inclusions
*Clear Lake soils on lower positions
*Columbia soils on similar positions
*Dello soils on similar positions
*Merritt soils on similar positions
Similar inclusions
*Areas with a surface layer of silty clay loam or clay loam on similar positions

Use and management
Land use: Irrigated crops and homesite development

Irrigated crops
Commonly grown crops: row and field crops
Major management factors: Dospalos= flooding, high water table, fine surface texture, restricted permeability; Bolfar= flooding, high water table, lateral seepage
*Flooding and high water table limitations should be considered when planning stand renovation or reestablishment
*Irrigation must be carefully managed to avoid raising the water table.
*Drainage systems that require continual maintenance have been used to lower the apparent water table to a depth of 3.5 to 5 feet.
*Tile drainage can be used to lower the water table if a suitable outlet is available.
*Areas adjacent to levees are subject to lateral seepage in wet years when the water level is high.
*The soil is too sticky to cultivate when it is wet and is too hard to cultivate when it is dry.
*The restricted permeability requires proper irrigation design with a low application rate and a longer application period to prevent stand deterioration.
*Returning crop residue to the soil or regularly adding other organic matter improves fertility, reduces crusting and increases the water intake rate.
*Furrow, border and sprinkler irrigation systems are suited to this soil.

Homesite development
Major management factors: Dospalos= flooding, high water table, shrink-swell, restricted permeability, low strength; Bolfar= flooding, high water table, restricted permeability, low strength
*Flooding and a high water table can occur during the winter and early spring months. The foundation should be taller than normal or the buildings located on the highest elevations. Water should be intercepted by drainage ditches or a drainage

system should be developed around the foundation.
*The effect of shrinking and swelling can be minimized by using proper engineering designs or backfilling material that has a low shrink-swell potential.
*Buildings and roads should be designed to offset the limited ability of the soil in this unit to support a load.
*When septic tanks are used, a high water table and restricted permeability decreases the absorption capacity of the leach field. A mounded leach field or other specialized leach field can overcome this limitation.
*Flooding can add additional water to the septic system. Diversion of flood waters reduces this limitation.

Interpretive groups
Capability: For both components= unit IIw-3, irrigated; IVw-3, nonirrigated for both components
MLRA: 17
Vegetative soil group:
E for both components

******180= Dello fine sandy loam, channeled, 0 to 2 percent slopes, frequently flooded**

Setting
Landform: Floodplains and old sloughs
Elevation: 25 to 50 feet
Landscape features: This unit is located in a designated floodway. Channeling and deposition are common along streambanks. Mottles in the profile indicate a very poorly drained soil; however, drainage has now been improved by levees and reclamation projects.
Slope features: Nearly level channeled with numerous intermittent drainageways.
Vegetation: Annual grasses, forbs and hydrophytic vegetation
Mean annual precipitation: 10 to 12 inches
Mean annual temperature: 60 to 62 degrees F
Frost-free period: 260 to 280 days

Composition
***Dello fine sandy loam and similar soils: about 85 percent
Dissimilar inclusions: 15 percent

Characteristics of the Dello soil--
Parent material: Alluvium from granitic rock sources

Typical profile:

Surface layer
**0 to 10 inches= pale brown fine sandy loam
Underlying material
**10 to 60 inches= mottled light brownish gray and light gray sand.

Depth class: Very deep
Depth to bedrock: Greater than 60 inches
Drainage class: Very poorly drained
Water table: 3 to 4 feet from the soil surface from December to April
Kind of water table: Apparent
Available water capacity: Moderate
Permeability: Rapid
Intake family: 1.5
Surface runoff: Negligible to very low
Highest shrink swell potential: Low
Hazard of flooding: Frequent, for brief to long periods, from December through April
Hazard of water erosion in bare areas: Slight
Corrosivity class: Steel= high; concrete= low

Minor Components
Dissimilar inclusions
*Columbia soils on similar positions
*Soils that have coarse textured surfaces or that have buried moderately fine or fine textured substrata below a depth of 30 inches on similar positions.
Similar inclusions
*Areas with a surface layer of loamy fine sand or sandy loam

Land use: wildlife habitat, irrigated crops

Wildlife habitat
Major management factors: Few limitations

Irrigated crops
Commonly grown crops: row and field crops
Major management factors: Channeled landscape, flooding, high water table, lateral seepage, coarse textured underlying material
*Land leveling the channeled landscape may require deep cuts that will expose highly variable stratified substrata.
*Flooding and high water table limitations should be considered when planning stand renovation or reestablishment.
*Irrigation must be carefully managed to avoid raising the water table.
*Tile drainage can be used to lower the water table if a suitable outlet is available.
*Drainage systems that require continual maintenance have been used to lower the apparent water table to a depth of 3 to 4 feet.

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*This unit is subject to lateral seepage in wet years when the water level is high.
*Water should be applied in amounts sufficient to wet the root zone but in amounts small enough to minimize the leaching of plant nutrients.
*Furrow, border and sprinkler irrigation systems are suited to this soil.

Interpretive groups
Capability: Unit IIIw-4, irrigated; IVw-4, nonirrigated
MLRA: 17
Vegetative soil group: B

****190= Clear Lake clay, 0 to 2 percent slopes, occasionally flooded

Setting
Landform: Basins
Elevation: 25 to 50 feet
Landscape features: This unit is located in a designated floodway. Mottles in the profile indicate a poorly drained soil; however, drainage has now been improved by levees and reclamation projects.
Slope features: Nearly level
Vegetation: Annual grasses and forbs
Mean annual precipitation: 10 to 12 inches
Mean annual temperature: 60 to 62 degrees F
Frost-free period: 260 to 280 days

Composition
***Clear Lake clay and similar soils: about 85 percent
Dissimilar inclusions: 15 percent

Characteristics of the Clear Lake soil--
Parent material: Alluvium from sandstone and shale

Typical profile:

Surface layer
**0 to 16 inches= gray clay
Subsoil
**16 to 60 inches= dark gray clay

Depth class: Very deep
Depth to bedrock: Greater than 60 inches
Drainage class: Poorly drained, now partially drained
Water table: 3 to 6 feet from the soil surface from December to April
Kind of water table: Apparent
Available water capacity: High
Permeability: Slow
Intake family: 0.1
Surface runoff: Negligible to medium
Highest shrink swell potential: High
Hazard of flooding: Occasional, for brief to long periods, from December through April
Hazard of water erosion in bare areas: Slight
Corrosivity class: Steel= high; concrete= moderate

Minor Components
Dissimilar inclusions
*Columbia soils on similar positions
*Dello soils on similar positions
*Dospalos soils on similar positions
Similar inclusions
*Areas with a surface layer of clay loam

Use and management
Land use: Irrigated crops, homesite development

Irrigated crops
Commonly grown crops: row and field crops
Major management factors: Flooding, high water table, fine surface texture, restricted permeability
*Flooding and high water table limitations should be considered when planning stand renovation or reestablishment
*Irrigation must be carefully managed to avoid raising the water table.
*Drainage systems that require continual maintenance have been used to lower the apparent water table to a depth of 3 to 6 feet.
*Tile drainage can be used to lower the water table if a suitable outlet is available.
*The soil is too sticky to cultivate when it is wet and is too hard to cultivate when it is dry.
*The restricted permeability requires proper irrigation design with a low application rate and a longer application period to prevent stand deterioration.
*Returning crop residue to the soil or regularly adding other organic matter improves fertility, reduces crusting and increases the water intake rate.
*Furrow, border and sprinkler irrigation systems are suited to this soil.

Homesite development
Major management factors: Flooding, high water table, shrink-swell, restricted permeability, low strength.
*Flooding and a high water table can occur during the winter and early spring months. The foundation should be taller than normal or the buildings located on the highest elevations. Water should be intercepted by drainage ditches or a drainage system should be developed around the foundation.
*The effect of shrinking and swelling can be minimized by using proper engineering designs or backfilling

material that has a low shrink-swell potential.
*Buildings and roads should be designed to offset the limited ability of the soil in this unit to support a load.
*When septic tanks are used, a high water table and restricted permeability decreases the absorption capacity of the leach field. A mounded leach field or other specialized leach field can overcome this limitation.
*Flooding can add additional water to the septic system. Diversion of flood waters reduces this limitation.

Interpretive groups
Capability: Unit IIw-5, irrigated; IVw-5, nonirrigated
MLRA: 17
Vegetative soil group: C

******195= Clear Lake clay, 0 to 2 percent slopes, rarely flooded**

Setting
Landform: Basins
Elevation: 25 to 50 feet
Landscape features: The construction of a system of levees and large upstream dams has reduced the hazard of flooding. Mottles in the profile indicate a poorly drained soil; however, drainage has now been improved by levees and reclamation projects.
Slope features: Nearly level
Vegetation: Annual grasses and forbs
Mean annual precipitation: 10 to 12 inches
Mean annual temperature: 60 to 62 degrees F
Frost-free period: 260 to 280 days

Composition
***Clear Lake clay and similar soils: about 85 percent
Dissimilar inclusions: 15 percent

Characteristics of the Clear Lake soil--
Parent material: Alluvium from sandstone and shale

Typical profile:

Surface layer
**0 to 16 inches= gray clay
Subsoil
**16 to 60 inches= dark gray clay

Depth class: Very deep
Depth to bedrock: Greater than 60 inches
Drainage class: Poorly drained
Water table: 3 to 6 feet below the soil surface from December through April
Kind of water table: Apparent
Available water capacity: High
Permeability: Slow
Intake family: 0.1
Surface runoff: Negligible to medium
Highest shrink swell potential: High
Hazard of flooding: Rare
Hazard of water erosion in bare areas: Slight
Corrosivity class: Steel= high; concrete= moderate

Minor Components
Dissimilar inclusions
*Columbia soils on similar positions
*Dello soils on similar positions
*Dospalos soils on similar positions
Similar inclusions
*Areas with a surface layer of clay loam

Use and management
Land use: Irrigated crops, homesite development

Irrigated crops
Commonly grown crops: row and field crops
Major management factors: Flooding, high water table, fine surface texture, restricted permeability
*Flooding and high water table limitations should be considered when planning stand renovation or reestablishment
*Irrigation must be carefully managed to avoid raising the water table.
*Drainage systems that require continual maintenance have been used to lower the apparent water table to a depth of 3 to 6 feet.
*Tile drainage can be used to lower the water table if a suitable outlet is available.
*The soil is too sticky to cultivate when it is wet and is too hard to cultivate when it is dry.
*The restricted permeability requires proper irrigation design with a low application rate and a longer application period to prevent stand deterioration.
*Returning crop residue to the soil or regularly adding other organic matter improves fertility, reduces crusting and increases the water intake rate.
*Furrow, border and sprinkler irrigation systems are suited to this soil.

Homesite development
Major management factors: Flooding, high water table, shrink-swell, restricted permeability, low strength.
*Flooding and a high water table can occur during the winter and early spring months. The foundation should be taller than normal or the buildings

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located on the highest elevations. Water should be intercepted by drainage ditches or a drainage system should be developed around the foundation.
*The effect of shrinking and swelling can be minimized by using proper engineering designs or backfilling material that has a low shrink-swell potential.
*Buildings and roads should be designed to offset the limited ability of the soil in this unit to support a load.
*When septic tanks are used, a high water table and restricted permeability decreases the absorption capacity of the leach field. A mounded leach field or other specialized leach field can overcome this limitation.
*Flooding can add additional water to the septic system. Diversion of flood waters reduces this limitation.

Interpretive groups
Capability: Unit= IIw-5, irrigated; IVw-5, nonirrigated
MLRA: 17
Vegetative soil group: C

******200= Veritas sandy loam, 0 to 2 percent slopes, rarely flooded**

Setting
Landform: Low fan terraces
Elevation: 25 to 50 feet
Landscape features: The construction of a system of levees and large upstream dams has reduced the hazard of flooding
Slope features: Nearly level
Vegetation: Annual grasses and forbs
Mean annual precipitation: 11 to 12 inches
Mean annual temperature: 60 to 61 degrees F
Frost-free period: 260 to 270 days

Composition
***Veritas sandy loam and similar soils: about 85 percent
Dissimilar inclusions: 15 percent

Characteristics of the Veritas soil--
Parent material: Alluvium from mixed rock sources

Typical profile:

Surface layer
**0 to 21 inches= grayish brown and brown sandy loam
Subsoil
**21 to 41 inches= brown and pale brown sandy loam
Hardpan
**41 to 60 inches= indurated light gray hardpan

Depth class: Deep
Depth to hardpan: 40 to 60 inches
Depth to bedrock: Greater than 60 inches
Drainage class: Moderately well drained
Water table: Greater than 6 feet, but water may be perched for very brief periods above the hardpan after heavy rains or irrigations.
Available water capacity: Moderate
Permeability: Moderately rapid
Intake family: 1.5
Surface runoff: Negligible to very low
Highest shrink swell potential: Low
Hazard of flooding: Rare
Hazard of water erosion in bare areas: Slight
Corrosivity class: Steel= moderate; concrete= low

Minor Components
Dissimilar inclusions
*Columbia soils on slightly lower positions
*Dello soils on slightly lower positions
*Dospalos soils on slightly lower positions
*Merritt soils on slightly lower positions
Similar inclusions
*Areas with a surface layer of fine sandy loam

Use and management
Land use: Irrigated crops and homesite development

Irrigated crops
Commonly grown crops: row, field and orchard crops
Major management factors: Depth to hardpan, flooding
*Assuming the hardpan has not been ripped, frequent irrigation cycles and controlled application rates should be applied to prevent a perched watertable.
*The hardpan reduces the yield of deep rooted crops. Where feasible, deep ripping of this restrictive layer helps to overcome this limitation.
*Flooding hazard limitations should be considered before any cropping or capital improvements are installed.
*Furrow, border and sprinkler irrigation systems are suited to this soil.

Homesite development
Major management factors: Depth to hardpan, flooding
*The hard pan reduces soil volume available for filtering effluent. Tests should be made below the pan depth to determine if the lines should be placed at this depth.
*Flooding can occur during the winter and early spring months. The foundation should be taller than normal or the buildings located on the highest elevations. Water should be intercepted by

Soil Descriptions

drainage ditches or a drainage system should be developed around the foundation.
*Flooding can add additional water to the septic system. Diversion of flood waters reduces this limitation.
Interpretive Groups
Capability: Veritas= unit IIs-8, irrigated; IVs-8, nonirrigated
MLRA: 17
Vegetative soil group: A

******210= Cortina gravelly sandy loam, 0 to 2 percent slopes.**

Setting
Landform: Alluvial fans
Elevation: 25 to 275 feet
Slope features: Nearly level
Vegetation: Annual grasses and forbs
Mean annual precipitation: 12 to 14 inches
Mean annual temperature: 60 to 62 degrees F
Frost-free period: 260 to 280 days

Composition
***Cortina gravelly sandy loam and similar soils: about 85 percent
Dissimilar inclusions: 15 percent

Characteristics of the Cortina soil--
Parent material: Alluvium from mixed rock sources

Typical profile:

Surface layer
**0 to 6 inches= light brownish gray gravelly sandy loam
Underlying material
**6 to 38 inches= pale brown and light brownish gray stratified very gravelly loamy sand and very gravelly loam
**38 to 60 inches= pale brown stratified very gravelly sand to very gravelly loamy sand

Depth class: Very deep
Depth to bedrock: Greater than 60 inches
Drainage class: Somewhat excessively drained
Water table: Greater than 6 feet
Available water capacity: Low
Permeability: Rapid
Intake family: 1.5
Surface runoff: Negligible to low
Highest shrink swell potential: Low
Hazard of flooding: Rare
Hazard of water erosion in bare areas: Slight
Corrosivity class: Steel= moderate; concrete= moderate

Minor Components
*Dissimilar inclusions
*Stomar soils on higher positions
*Zacharias soils on higher positions
*Xerofluvents on slightly lower positions
*Xerorthents on slightly lower positions
Similar inclusions
*Areas with a surface layer of very gravelly sandy loam

Use and management
Land use: Irrigated crops and homesite development

Irrigated crops
Commonly grown crops: row, field and orchard crops
Major management factors: high gravel content, limited available water capacity
**The high percentage of gravel in this soil reduces the amount of moisture available for plant growth and can cause rapid wear of tillage equipment.
*Coarse textured soils require short and frequent irrigation cycles to prevent deep percolation losses and ground water contamination.
*Water should be applied in amounts sufficient to wet the root zone but in amounts small enough to minimize the leaching of plant nutrients.
*Sprinkler and drip irrigation systems are suited to this unit. Use of this method permits the even, controlled application of water.

Homesite development
Major management factors: Flooding, poor filter
*Flooding can occur during the winter and early spring months. The foundation should be taller than normal or the buildings located on the highest elevations. Water should be intercepted by drainage ditches or a drainage system should be developed around the foundation.
*The coarse texture limits filtering capacity. Inadequately filtered effluent can contaminate the surface or ground water. Special designs can overcome this limitation.
*As the density of homesites increase, a community disposal system should be considered.

Interpretive groups
Capability: Cortina= unit IIIs-4, irrigated: IVs-4, nonirrigated
MLRA: 17
Vegetative soil group: B

******215= Yokut sandy loam, 0 to 2 percent slopes**